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28th Annual Session
AMERICAN CONGRESS OF PHYSICAL MEDICINE

August 28, 29, 30, 31, September 1, 1950

HOTEL STATLER — BOSTON

VOLUME XXXI FEBRUARY, 1950 NO. 2

American Congress of Physical Medicine

28th Annual

Scientific and Clinical Session

and

Instruction Course

August 28, 29, 30, 31, Sept. 1, 1950

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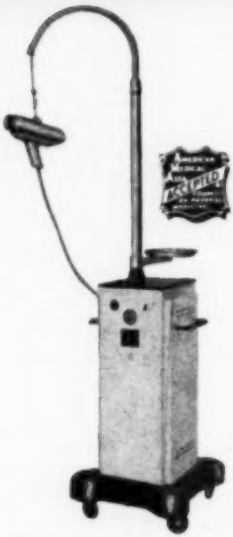

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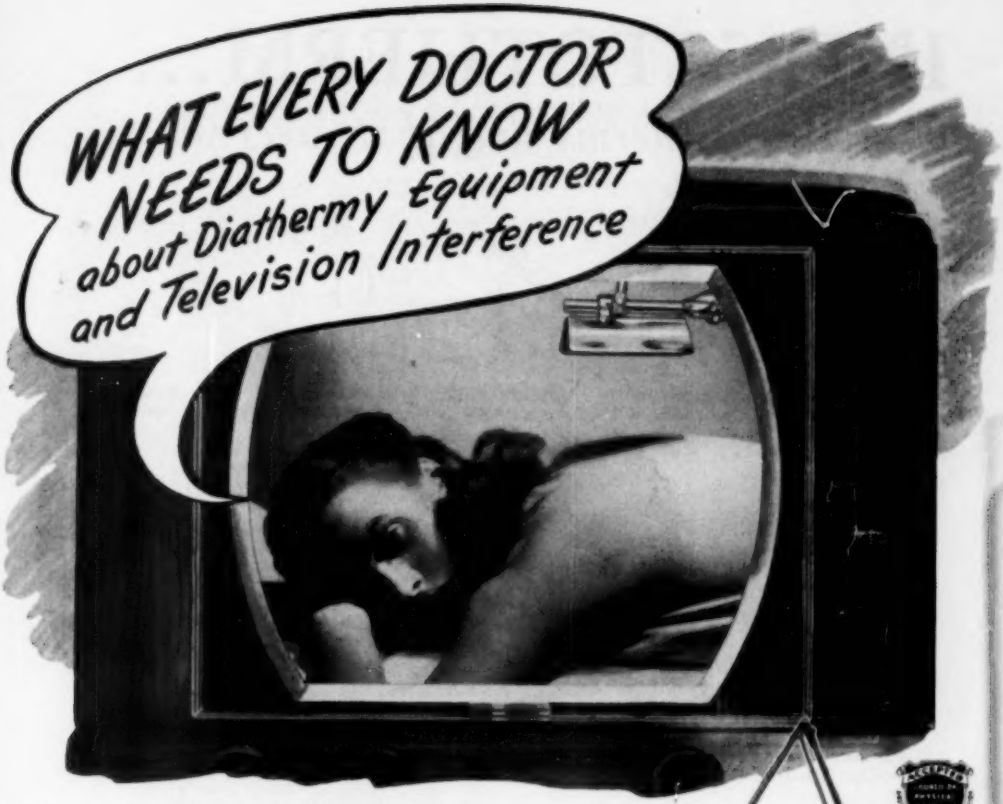

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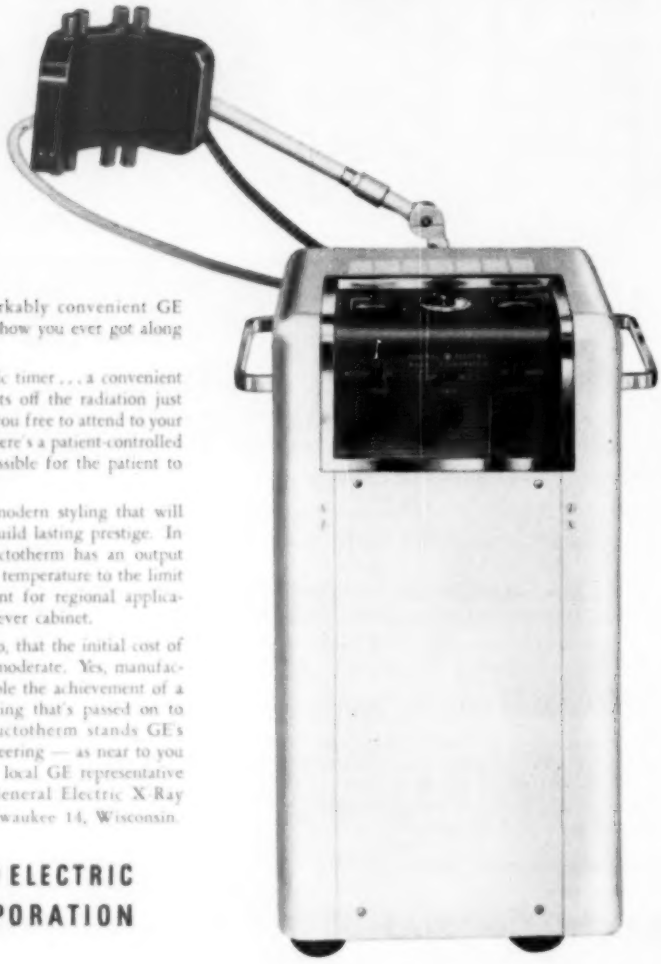

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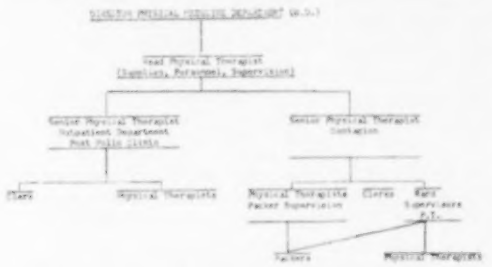
ADMINISTRATION OF THE PHYSICAL MEDICINE DEPARTMENT, LOS ANGELES COUNTY HOSPITAL, DURING THE 1948 POLIOMYELITIS EPIDEMIC *

ELIZABETH AUSTIN, M.D.
O. LEONARD HUDDLESTON, M.D., Ph.D.
and
ALBERT G. BOWER, M.D., F.A.C.P.

LOS ANGELES

In the 1948 epidemic of poliomyelitis at the Los Angeles County Hospital, the physical medicine department was responsible for all physical therapy procedures and personnel and for the discharge of patients.

Under the medical director of the department (the table) the head therapist was charged with procuring supplies, orienting new personnel and supervising all employees. This was carried out through senior physical therapists of the permanent staff. As far as possible members of the department were placed in key positions in the wards because of their familiarity with hospital procedure, and recruited therapists were assigned to them as needed.



Administrative setup of the physical medicine department of the Los Angeles County Hospital in the 1948 Poliomyelitis Epidemic.

The ratio of 6 respirator patients to 1 therapist was maintained whenever possible, and the same ratio was used in wards where there were other severely involved patients. One therapist handled 10 or 12 less seriously involved patients, and an average of 8 patients was assigned to each packer.

Physical therapists were recruited by the National Foundation for Infantile Paralysis and worked a forty hour week. However, a full complement of therapists was maintained seven days a week by using additional personnel.

Packers were recruited and trained in contagious technic and fundamental packing procedures by the senior physical therapist in the Communicable Disease Unit. As the number of patients increased, a physical therapist was assigned to instruct and supervise packers. In addition, packers were responsible directly to the supervising physical therapist in each ward.

The director of the department set all treatment policies and in addition was responsible for the disposition of all patients. Check-out examinations

* From the Department of Physical Medicine and the Communicable Disease Unit, Los Angeles County Hospital and University of Southern California School of Medicine.

were done two or three days before the end of the quarantine period to allow time for arrangements to be made for transfer. A muscle check at the time of discharge was made by the therapist, and, if additional hospitalization elsewhere was indicated, a duplicate muscle check, together with a written report of the patient's course in the hospital, was sent to the next hospital.

At the end of quarantine, patients fell into three categories. Those with minor residual involvement only — i. e., slight muscle shortening or very slight weakness of the upper extremities — were discharged to their homes with instructions for rest, activity and exercise. Patients with moderate to marked weakness and muscle shortening, or with the latter alone when severe, were discharged to other hospitals. Respirator patients, stand-by respirator patients and those with complications were held until it was thought safe to move them to other hospitals having the required facilities.

Patients sent home received the following instructions:

Home Instructions for Rest and Activity for Poliomyelitis Patients

According to the current policy of the Los Angeles County Hospital, only patients known to have had a non-paralytic type of anterior poliomyelitis are discharged to the home for treatment. It will be recalled that such patients have been confined to bed for a period of approximately two weeks. Physical rehabilitation, therefore should be graded to restore sufficient strength and endurance so that the patient may resume former activities or occupation. A hard bed should be used for at least one month, no foot board being needed; bathroom privileges, including bathing are permitted immediately; continued bed rest for one week is recommended. The amount of activity permitted should be as follows:

Day	A. M.	P. M.	Evening
1st	1 hr.	1 hr.	
2nd	1½ hr.	1½ hr.	
3rd	2 hr.	2 hr.	
4th	2½ hr.	2½ hr.	
5th	3 hr.	3 hr.	
6th	4 hr.	4 hr.	
7th	May be up all day, limited activity		Activity restricted
8th	Limited activity		1 hr activity
9th	Limited activity		2 hr. activity
10th-14th	Limited activity		3 hr. activity

Two weeks after leaving the hospital a check-up is made in the convalescent poliomyelitis clinic. The amount of activity will be recommended by the examining doctor. This rest and activity program is recommended to permit gradual and progressive recovery of strength. Over activity should be avoided for it may develop complications which might ultimately cause deformities or minor physical defects. The routine exercises are to be followed and continued throughout the two weeks of home treatment.

These suggestions should be carefully considered in the activity and rest program:

Strenuous physical exertion should be avoided at all times, particularly the following — swimming, bicycle riding, roller skating, rowing and strenuous games such as basketball, football, handball, boxing, wrestling and distance running.

If any tightness, soreness, pain or weakness of any muscle develops during the two week period after leaving the hospital, the symptoms should be reported immediately to your doctor, a recognized poliomyelitis clinic, the public health nurse or the department of physical medicine at the Los Angeles County Hospital.

The following routine exercise instructions were given to nonparalytic patients on discharge home:

Home Exercises for Poliomyelitis Patients

These exercises are to be done ten times each, four times a day. If there is slight pain on doing these exercises, a comfortably warm, but not hot, bath for fifteen to twenty minutes will be helpful preceding them.

Exercise No. 1

(*a*) Patient seated erect on bed or floor with legs extended.
(*b*) From the fully erect sitting position, bend forward and touch the toes with the fingertips, keeping the knees straight and the head bent.
(*c*) Return to the former erect sitting position with arms extended.

Exercise No. 2

(*a*) Starting position same as above except that the hands are placed back of the head, and the chin flexed on the chest.
(*b*) Bend forward and attempt to touch forehead to knees.
(*c*) Resume position "a."

Exercise No 3

(*a*) Sit on side of bed with feet flat on floor, stool or chair. Place hands behind head, touch chin to chest.
(*b*) Attempt to curl trunk down so that forehead touches bed between knees.
(*c*) Resume erect position.

After two weeks at home the patients returned to the outpatient poliomyelitis clinic. At that time another muscle check was done and the patient was examined by the physician in charge to determine the relative amount of muscle shortening and weakness present. It was the feeling of the medical director of the department that nonparalytic patients with poliomyelitis should be followed for scoliosis at six months intervals until full growth was attained. At the time of this visit patients were discharged to the care of their physician for continued care if requested. If muscle shortening or slight weakness persisted, they were given detailed instructions for stretching exercises at home and, in addition, were requested to come to the department several times weekly for adequate supervision of exercises and stretching procedures. They were then checked at intervals of three to six weeks to determine progress.

The public health nurses of the city and county received duplicate reports of the check-out examination, together with any special instructions given the patient. They had already been familiarized with routine procedure in a special meeting with the staff of the department. The nurses visited each home a few days after the patient returned from the hospital. They were of great assistance in clarifying instructions to parents, and they have continued to visit the patients at intervals.

The second type of patients at the end of quarantine were those with moderate to marked muscle shortening, tenderness and stretch pain with or without weakness for whom additional hospitalization was required. Arrangements for hospitalization were made on our recommendation through the social service department, and the patients were sent out at the end of fourteen days for other hospitalization and eventually outpatient care by these institutions.

Patients whose medical condition did not permit discharge constituted the third group. This included respirator and stand-by respirator patients, patients with open tracheotomies or with Levin tubes still in place or who had pneumonia, urinary or other complications.

The personnel required for the care of the respirator and stand-by respirator patients made it extremely difficult to place these patients in other hospitals, and for a time a large number of patients continued to remain in the wards for treatment. Gradually, however, other facilities were developed,

and, as the patient's conditions stabilized and it become safe to move them, they were discharged.

A number of patients were moved in the respirator without mishap on special ambulance trucks developed for the purpose. Specific details of this procedure will be covered in another paper. In general, however, discharge instructions were entered on the chart and were sent at least forty-eight hours before the proposed transfer to the chief medical resident, the transportation department and to the next hospital. Upon removal, a doctor and nurse accompanied each patient. Suction apparatus and oxygen were available during the transfer, and a special motor was installed on the truck to keep the respirator going during the trip. Great care was exercised in transferring these patients, and orders for this transfer originated in the department of physical medicine after consultation with the senior resident physician on the communicable disease unit.

Patients who could be out of the respirator for an hour or more were moved by regular ambulance with a doctor and nurse in attendance and with suction and oxygen available. In addition, a portable positive pressure resuscitation unit was sent with the patient if advisable.

With use of these procedures, more than 80 patients were moved in respirators without mishap for variable distances, the maximum being fifty miles.

A MIRROR FOR USE ON RESPIRATORS *

ELIZABETH AUSTIN, M.D.
O. L. HUDDLESTON, M.D., Ph.D.
RUTH NYGREN, R.P.T.T.
and
ALBERT G. BOWER, M.D., F.A.C.P.

LOS ANGELES

As many as 82 respirator patients were treated at one time during the 1948 poliomyelitis epidemic, and it was felt that through the weeks the care and morale of these patients would be helped by properly constructed mirrors. A number of types were tried with varying success.

Mirrors which proved to be ideal were eventually developed through the kindness of a large motion picture studio. They could be readily attached to any type of tank respirator, could not fall down on the patient, permitted the respirator to be opened without detaching the mirror, and could be adjusted so that the therapist or nurse working at the lower end of the respirator could watch the patient's face. The back of the mirror could be used for a reading rack. The plans for this mirror are shown in figure 1, and the mirror as it is attached and in use is shown in figure 2. They have been rapidly adopted by other hospitals.

* From the Department of Physical Medicine and the Communicable Disease Unit, Los Angeles County Hospital and University of Southern California School of Medicine.

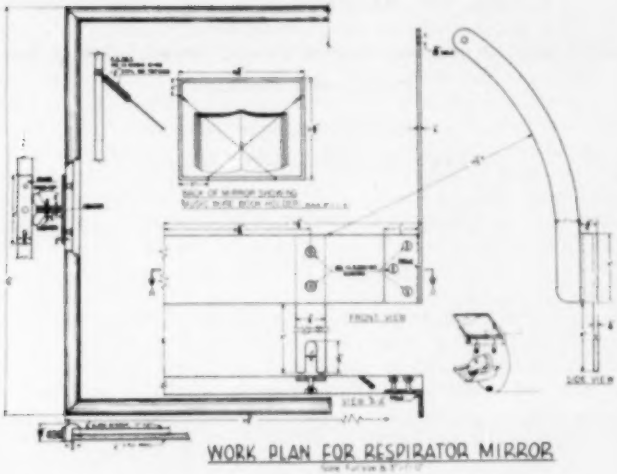


Fig. 1. — Work plan of the respirator mirror used at the Los Angeles County Hospital. (Courtesy of Metro-Goldwyn-Mayer Studios.)

Fig. 2. — Back of the mirror, showing the reading rack.

PHYSICAL MEDICINE PROCEDURES IN THE CARE OF RESPIRATOR PATIENTS *

Measures Used in the Los Angeles County Hospital During the 1948 Poliomyelitis Epidemic

ELIZABETH AUSTIN M.D.
O. LEONARD HUDDLESTON, M.D., Ph.D.
and
ALBERT G. BOWER, M.D., F.A.C.P.
LOS ANGELES

The objectives of physical medicine in the treatment of respirator patients are the same as those for other patients afflicted with poliomyelitis: (1) to allay the acute neuromuscular phenomena of muscle shortening, irritability, stretch pain and tenderness; (2) to prevent or minimize musculoskeletal deformities and (3) to establish patterns of functional motion so that the patient will make the most effective use of residual muscle power.

That the patient is in the respirator and acutely ill during early phases of the disease makes the carrying out of these objectives particularly difficult, and procedures consequently are often limited to positioning to prevent and minimize skeletal deformities.

Patients who manifest respiratory difficulties present special problems in physical therapy technics. Physical therapy procedures are elective procedures and must never interfere with the medical or nursing care of these acutely ill patients.

Roughly, patients requiring respirator care fall into three general groups: those with bulbar involvement alone, those with spinal involvement alone and those with a combination of the two.

Packing

Patients with bulbar involvement alone, who eventually require respirator care, are acutely ill and often have tracheotomies and Levin tubes. They require constant suctioning and frequently have high temperatures, irrational episodes, atelectasis, pulmonary edema, and other medical emergencies. Consequently, no physical medicine procedures such as packs are used until a patient's condition is stabilized. Occasionally, however, packs are ordered applied to one or another extremity for relief of transient pain or tenderness. Positioning, however, is carefully watched, although this is not a problem with these patients, as by definition none has more than minor weakness.

There is often muscle shortening, particularly of back, hamstrings and shoulder adductors, due to the limitation of motion imposed by their position in the respirator. This shortening is rather easily relieved, either by the use of supine packs or by Kenny packs to the affected areas, together with active stretching after the patient can be treated either in or out of the respirator.

Patients with respiratory embarrassment as a result of spinal involvement of either the diaphragm or the intercostal muscles or both present a

* From the Department of Physical Medicine and the Communicable Disease Unit, Los Angeles County Hospital and University of Southern California School of Medicine.

different problem. They frequently have marked shortening, tenderness and stretch pain of the back and neck extensors, the intercostals and the shoulder adductors.

Early it is difficult to differentiate between muscle shortening and actual weakness of the muscle of respiration, for respiratory excursion is frequently diminished by opisthotonus or by pain. When the temperature is below 101 or 102 F. it is possible to use continuous chest packs in an attempt to relieve the chest pain, tenderness and intercostal shortening. These chest packs are cut so that they extend over the deltoids and from the suprasternal notch to the symphysis pubis. They consist of four layers of Munsingwear covered only with Pliofilm and are changed every fifteen minutes during the day and continued during the evening and night when necessary. In addition, when the patient can be moved other packs are applied to areas of tenderness and pain in an attempt to relieve him of breathing difficulty.

When the patient is placed in the respirator, all packs are discontinued except continuous chest packs. When his condition is stabilized half packs are begun, that is, upper and lower extremities are packed alternately. Full lay-on packs usually prove too devitalizing.

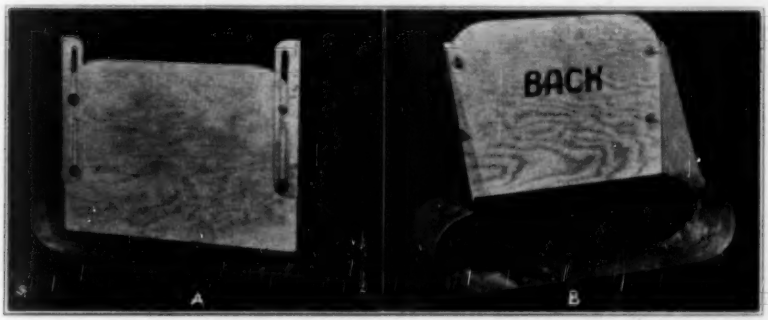


Fig. 1. — Respirator foot board; *A*, viewed from head of respirator, and *B*, viewed from foot of respirator. It is slid over the end of the mattress and clamped down by screws sliding in slots (*A*) and firmly fixed by tightening four set screws shown in *B*.

As the patient's condition improves, packs are preliminary to the initiation of range of motion and gentle stretching exercises, combined with muscle reeducation as indicated and tolerated.

Positioning

Positioning is very important to prevent or minimize musculoskeletal deformities in the respirator patient, and early in the disease this may be the only method of treatment for which physical medicine can be responsible.

The large number of respirator patients present in our wards, sometimes 80 or more, made it necessary for us to work out procedures which are suitable for mass application.

Equipment used for positioning must meet the following requirements: (1) It must be easily cleaned; (2) it must be easily replaced (complicated casts and other pieces of apparatus are often lost or destroyed by attendants); (3) it must be simple in application and (4) it must be light in weight.

Respirators of all types are used in our wards, and this made it necessary for us to develop a foot board which could be readily adjusted to the patient's

length and easily transferred from one type of respirator to another. The carpenter, consequently, designed and constructed foot boards for us which are simple to adjust and which can be used interchangeably in different types of respirators (fig. 1). These are slipped over the end of the mattress and clamped firmly at the proper place by setting the four setscrews which are seen on the back (fig. 1*B*). These screws slip in the slots shown in figure 1*A*.

Ankle, knee and hand rolls are used routinely for these patients, and, in addition, pillows are sometimes used for buttocks pads to relieve sacral pressure.

Special care to prevent bed sores is required; this must be carefully watched. Sponge rubber rings and standard rubber rings are not satisfactory in preventing the occurrence of bed sores in patients who are in the respirator for long periods; they are difficult to use and sometimes aggravate sacral pressure. Air mattresses finally solved the problem well, though some patients still show a marked tendency toward breakdown of tissue and pillows are necessary in these cases.

Sand bags are used to position lower extremities to prevent external rotation, but they are not used under knees or ankles or to position feet.

Long sponge rubber rolls wrapped in towels or diapers are used for knee and ankle rolls. Knee rolls are 4 by 4 inches and about 14 inches long; ankle rolls are 4 by 2 inches and the same length. Moderately firm sponge rubber is purchased in sheets, cut and kept available. Smaller rolls of various sizes can be easily made for children.

Prevention of contractures and deformities of the hands of respirator patients is a serious problem. Cock-up splints are difficult to make because

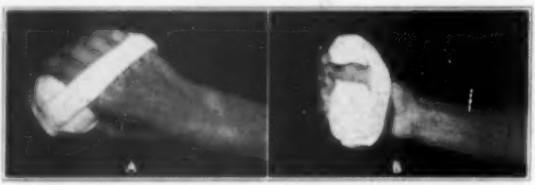


Fig. 2. — Simple hand roll.

it is necessary to work through respirator portholes. Too frequently they are lost or broken. Consequently, a small hand roll is now used which is made in various sizes to fit each patient's hand. This sponge roll is covered with stockinet and a small strip of stockinet taped over the roll to hold it on the hand and to hold the thumb in apposition (fig. 2). These are satisfactory, for they are easily applied, cleansed and replaced.

Mirrors for use of respirator patients presented a problem eventually solved through the kindness of one of the large motion picture studios. The ideal mirror can be easily attached to any type of tank respirator, cannot fall down on the patient's head and permits the respirator to be opened without detaching the mirror.

Mirrors were eventually developed which were ideal, for they met these specifications and, in addition, could be adjusted so that the therapist or nurse working at the lower end of the respirator could watch the patient's face. The back of the mirror could be used for a reading rack (fig. 3). Late in the epidemic, it was possible for the patients to see motion pictures in the respirator wards by using these mirrors.

Muscle Reeducation

Muscle reeducation is given for short periods several times daily because of the difficulty of working through portholes and because the patient tires easily.

For the respirator patient, the most important part of muscle reeducation relates to impaired intercostal and diaphragm function. Complete removal of the patient from the respirator to the bed is a complex problem which can be handled only by close cooperation between the medical and the nursing staffs.

As soon as the patient's condition has been stabilized and he has been afebrile for forty-eight hours, the therapist makes as complete an analysis of residual respiratory power as possible. This usually is done early in the morning before the patient is tired. The therapist may open the respirator and roll the patient out, or she may simply open a porthole for a brief period. At the first sign of distress — dilating the nostrils, using sternomastoids or other accessory muscles of respiration, "blacking-out," etc., the patient is returned to the respirator, even though the request be based on psychogenic rather

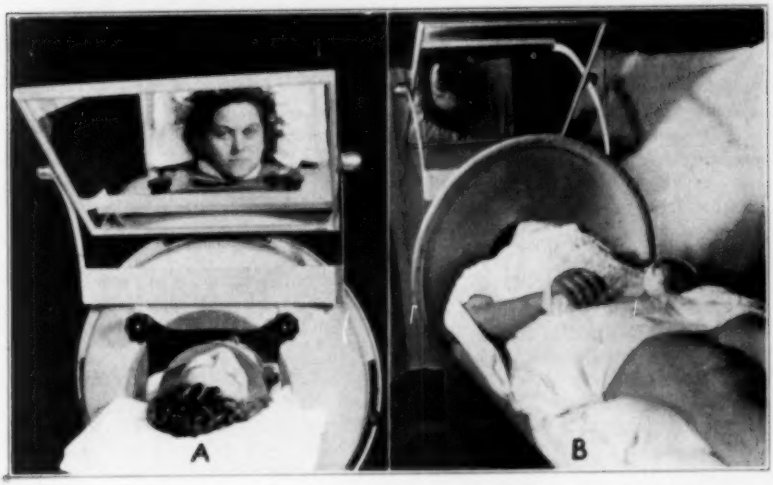


Fig. 3. — *A*, respirator mirror in place. *B*, patient properly positioned, showing use of the mirror to observe the patient's face from the lower end of the respirator. Note the hand rolls in position and the railing beside the elbow. The latter is a metal chart back folded in half lengthwise, covered with a diaper and partially slid under the mattress.

than respiratory factors. After a short period of rest he may be removed again. The result of this analysis together with the time the patient is able to tolerate being out of the respirator without distress is then noted on the physical therapy sheet.

With the physiatrist a program for removal from the respirator is set up. This is subject to constant change as the physical and psychologic condition of the patient changes.

When the patient tolerates being out of the respirator less than three minutes the head of the respirator is not opened, but the pressure is made ineffective by opening a port. This may be done several times a day, depending on his condition, and specific instructions are given for the use of

the diaphragm and intercostal muscles. When the patient tolerates longer periods out of the respirator, he may be removed from it for routine physical therapy procedures.

The patient is returned to the respirator under the following conditions: (1) rise of pulse rate of 20 points, (2) slight cyanosis of nail beds or mucous membranes, (3) substitution of accessory muscles for usual respiratory muscles, (4) profuse perspiration, (5) patient requests return. Specific orders are usually written — "patient to be removed from the respirator (or, open respirator port) to tolerance, but not more than five minutes three times daily, etc." The patient is checked frequently by the medical staff with the therapists so that orders keep pace with his progress. As he improves, he is out of the respirator for longer periods at more frequent intervals and, when possible, he is placed on a bed when he has been out of the respirator more than two hours. It is carefully explained to him that staying out of his respirator is not an endurance contest and that he may not be able to stay out for the same period of time each day. While out of the respirator, he is under constant observation for changing pulse rate, changing respiratory rate, cyanosis and the use of the accessory muscles of respiration.

In addition to the method already described, some patients are encouraged to breathe with reduced negative pressure. The physician and therapist reduce the negative pressure gradually, observing the patient's respiratory motion. He is then allowed to breathe at reduced pressure for several minutes several times a day.

In general, short periods out of the respirator at frequent intervals are more helpful than long periods, which will tire the patient. Thus a patient may be out one minute every hour, increasing one minute a day as tolerated until fifteen or twenty minutes is reached. He may then be out twenty minutes to one-half hour four times a day. Setbacks may occur at any time.

Permanent removal of patients from the respirator is at present on an empiric basis and requires a good deal of experience. Respirometer and oximeter determinations are in the process of evaluation. Often a combination of the two methods discussed is used. Psychologic factors frequently play the most important part in the program.

It is emphasized that each patient presents an individual problem and must be handled individually. The patient must have confidence in the one who treats him, and the therapist must have ingenuity in handling his fears and problems.

RELATIONSHIP BETWEEN BODY POSITION AND THE APPLICATION OF MUSCLE POWER TO MOVEMENTS OF THE JOINTS *

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This study was begun as a research project in physical reconditioning in the Army Air Forces convalescent hospital program during the war, and continued at the Physical Education Research Laboratory, Springfield College, under auspices of the Office of Naval Research. In the course of this work apparatus and objective technics have been devised for measuring the strength of muscles activating movements of the joints.[1] These tests are intended for eventual application to muscles involved in orthopedic and neuromuscular disabilities.

Initially, twenty-eight tests were proposed, based on certain movements of the wrist, elbow, shoulder, hip, knee and ankle joints. Coefficients of objectivity between 0.92 and 0.97 were obtained for the various tests by the test-retest method with different testers and with nondisabled college men as subjects. A trial of the tests on patients with orthopedic disabilities at the U. S. Naval Hospital, Chelsea, Mass., revealed that, in general, the results coincided well with medical opinion of the patient's status.

In this type of objective testing of strength, a specially adapted and calibrated aircraft tensiometer was utilized to record the amount of tension the subject can apply to a cable appropriately placed for specified movements of the joint. A home-made pulling apparatus was used, as described in the original article by one of us (Clarke).[1] The subject was tested on a treatment table or plinth.

After extensive review by consultants on physical medicine at the Mayo Clinic, improvements in the testing process were studied during the past year by graduate students in physical education at Springfield College. Two phases of the research provide the basis for this paper: (1) the amount of muscle strength that may be applied for the same movement of a joint when the body is in different positions and (2) the amount of muscle power applied throughout the range of movements of each joint. Each of these phases will be discussed, not as a part of test construction but as a study of the relationship of test positions to the application of muscle power.

* Read at the Twenty-Seventh Annual Session of the American Congress of Physical Medicine, Cincinnati, Sept. 8, 1949.

1. Clarke, H. H.: Objective Strength Tests of Affected Muscle Groups Involved in Orthopedic Disabilities, Research Quart. 19:115-147 (May) 1948.

Effect of Changes in Body Position

Twelve of the original tests of strength were critically restudied in order to eliminate items of test equipment and to improve positions. The test positions for the various movements of the joints were reviewed critically and suggestions were made for kinesiologic improvement of several of them. Sixty-four nondisabled college men were then tested in both the original and the revised positions in order to compare their effectiveness on the amount of muscle strength applied.

In each case, the means of the tensions in both positions were computed. The differences between the means were tested for significance in accordance with the null hypothesis. On this basis, values for t[2] of 1.67 and 2.37 denoted significance at the 0.05 and 0.01 levels of confidence, respectively, for small samples. These values for t were chosen because, in this study, significance was measured from 0, or no difference, in a positive direction only. In explanation, at the 0.05 level the chances are 95 in 100 and at the 0.01 level the chances are 99 in 100 that there is a significant difference between the two methods, a difference that cannot be accounted for by chance. These are the minimum differences that are acceptable.[3]

The changes in the application of muscle power in both positions are given for movements of four joints: (1) adduction of the shoulder, (2) flexion of the hip, (3) extension of the knee and (4) extension of the ankle. In the test positions, the cable was always arranged at a right angle to the limb in order to act as a fulcrum, and the tensiometer was placed on the single strand part of the pulling apparatus.

In the studies which follow, 0 degrees is a position away from the median line of the body; 180 degrees parallels and is in line with the median line. Thus, for example, at 0 degrees in abduction of the shoulder the arm is over the head; and at 180 degrees it is close to the body.

Adduction of the Shoulder. — Original Form: 1. Position. The subject lies supine, with the hips and knees flexed, the feet resting on the table and the free arm on chest. The arm being tested is adducted at the shoulder to 160 degrees; the elbow is in the thrust position and the forearm is in the midprone-supine position.

2. Attachment. A strap is placed around the humerus midway between the shoulder and elbow joints. A cable is attached at the side of the arm being tested.

3. Stabilization. The tester prevents elevation of the shoulder by bracing.

Revised Form (fig. 1): The same position is used except that in order to eliminate the effect of the biceps, the humerus is rotated inward by turning the forearm across the chest; the hand is held low toward the opposite shoulder.

Results: The mean for the original form of the test was 63.00 pounds (28.6 Kg.); for the revised form, 52.25 pounds (23.7 Kg.). The experimental form was on the average 10.75 pounds (4.8 Kg.) less than the original form. This difference is attributed to the elimination of the biceps muscle from the test. The t was 3.90, indicating a statistically significant difference.

Flexion of the Hip. — Original Form: 1. Position. The subject lies supine with the leg not being tested, resting on the table and the arms folded on the chest. The hip of the thigh being tested is in 120 degrees of flexion; the knee is flexed, with the angle not specified.

2. Attachments. A strap is fastened around the lower third of the thigh. A cable is attached at the subject's feet.

3. Stabilization. The tester prevents lifting of the leg not being tested and raising of the hip of the leg tested by bracing.

2. The "t" indicates the ratio of the difference between two means and the standard error of the difference.

3. Fisher, R. A.: Statistical Methods for Research Workers, ed. 10, London, Oliver & Boyd, Ltd., 1946, p. 113. Garrett, H. E.: Statistics in Education and Psychology, ed. 2, New York, Longmans, Green & Co., 1949, pp. 190; 197-208.

Fig. 1. — Revised position and apparatus for testing muscle power in adduction of the arm at the shoulder.

Revised Form (fig. 2): 1. Position. The subject is sitting and leaning backward with the legs hanging free, the arms extended to the rear and the hands grasping the sides of the table. The hip on the side of the thigh being tested is flexed to 90 degrees and the knee is in 90 degrees flexion.

2. Attachments. A strap is attached around the lower third of the thigh. A cable is attached below the subject's leg.

3. Stabilization. The tester prevents lifting of the buttocks.

Results: The mean for the original form of the test was 64.81 pounds (29.4 Kg.); for the revised form, 115.00 pounds (52.2 Kg.). The average for

Fig. 2. — Revised position and apparatus used for testing muscle power during flexion of the hip.

Fig. 5. — Revised position and apparatus used for testing muscle power during extension of the knee.

the revised form was 50.19 pounds (22.8 Kg.) greater, an improvement of 77 per cent. The t was 15.78.

Apparently, the increased power demonstrated in the new position was due to the angle at which the iliopsoas muscle functioned. It is probable that the muscle applies its greatest rotary force when power is being exerted at a right angle to the longitudinal axis of the femur.

Extension of the Knee. — Original Form: 1. Position. The subject is in sitting position with the legs hanging free and the arms folded on the chest. The knee of the leg being tested is in 135 degrees of extension.

Fig. 6. — Revised position with apparatus used for testing muscle power during plantar flexion of the ankle.

2. Attachments. A strap is placed around the leg midway between the knee and the ankle; the cable is attached below and behind the subject.

3. Stabilization. The tester prevents lifting of the buttocks by bracing and prevents inward and outward rotation of the hip joint.

Revised Form (fig. 3): The position is the same as for the original test except that the subject is sitting and leaning backward with the arms extended to the rear and the hands grasping the sides of the table.

Results: The mean for the original form of the test was 112.94 pounds (51.3 Kg.); for the revised form, 147.94 pounds (67-1 Kg.). The average for the revised form was 35.00 pounds (15.9 Kg.) greater. The *t* was 4.86, indicating a statistically significant difference.

In the original testing position, the quadriceps muscles are in a shortened position, and the hamstring muscles offer countertension. In the revised position, the quadriceps muscles are more nearly at their full length and the tension of the hamstring muscles is not so great.

Plantar Flexion at the Ankle. — Original Form: 1. Position. The subject is in the sitting position with the legs hanging free and the arms folded on the chest. The knee is in 90 degrees of flexion, and the ankle being tested is in 90 degrees of plantar flexion, with midposition of inversion-eversion.

2. Attachments. A strap is placed around the foot over the metatarsophalangeal joints; a cable is attached overhead.

3. Stabilization. The tester braces the knee and leg to hold them in proper position and prevents lifting of the buttocks, inversion or eversion of the ankle and flexion of the metatarsophalangeal joints.

Revised Form (fig. 4): 1. Position. The subject lies in the supine position with the arms folded on the chest and the leg in 180 degrees of extension. The ankle being tested is in 90 degrees of plantar flexion, with midposition of inversion-eversion.

2. Attachments. A strap is placed around the foot at the metatarsophalangeal joints; a cable is attached beyond the subject's head.

3. Stabilization. The tester braces the shoulders to hold the subject in place and prevent raising of the leg, inversion or eversion of the ankle and flexion of the metatarsophalangeal joints.

Results: The mean for the original form of the test was 61.84 pounds (28.1 Kg.); for the experimental form, 129.50 pounds (58.7 Kg.). The average for the revised form was 67.66 pounds (30.7 Kg.) greater, an improvement of 109 per cent.

In the original form of the test, the gastrocnemius muscle is at a disadvantage. With the knee at 90 degrees of flexion, there is considerable loss of tension in this muscle due to the decreased distance between its origin and insertion. It is generally agreed, other factors being equal, that a muscle produces its greatest power when functioning at its greatest length.

Muscle Power Throughout Range of Movements of Joints

The muscle power exerted throughout the full range of motion for fourteen of the movements of joints was studied. In most instances, nine test positions were selected, approximately 20 degrees apart. The fatigue element from repeated maximal exertions of the same muscles, while present, was reduced by spaced testing and was equalized by systematically changing the sequence of tests for the various subjects. The subjects were 64 nondisabled male students at Springfield College.

Graphs were prepared showing the muscle power exerted throughout the range of motion of the joints tested. In general, three types of graphs were found, as follows: (1) ascending curves, that is, increase in strength on motion of joint from angles of 0 to 180 degrees; (2) descending curves, and (3) ascending-descending curves, with greatest strength exhibited in the center of the range. There are individual variations of pitch and plateaus within these classifications, which will be pointed out in the discussion.

Ascending Curves. — Tests of four of the joint movements revealed ascending curves. Two of these, flexion of the hip and extension of the knee, had steep pitches.

In tests of two other joints, tests of abduction and flexion of the shoulder, the strength exerted started low at 0 degrees, rose for a distance to a plateau in the center and finally rose again at 180 degrees.

Flexion of the Hip (fig. 5): For this test the revised position was used

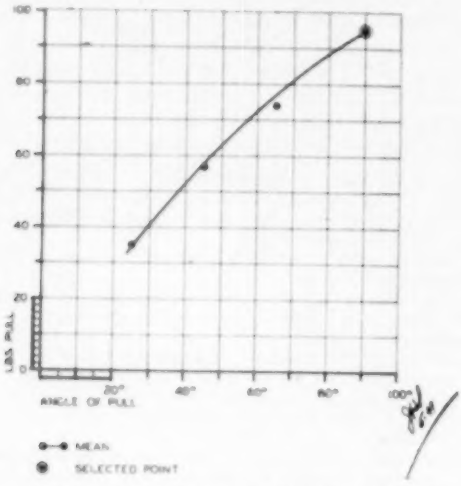

Fig. 5. — Muscle power exerted during flexion of the hip from 25 to 90 degrees.

(fig. 2). The subject was in a sitting position, leaning backward with the legs hanging free, the arms extended to the rear and the hands grasping the sides of the table. The hip on the side tested was in 180 degrees of adduction; the knee was in 90 degrees of flexion. The test was restricted to test the strength exerted from 25 degrees, close to the body, to 90 degrees, at a right angle sitting position. The subjects could pull only an average of 35 pounds (15.9 Kg.) with the thigh fully flexed, while recording an average of 90 pounds (40.8 Kg.), (plus the weight of the leg) when the flexors of the thigh were on greater stretch. The pitch of the curve representing strength exerted is very sharp, being a straight line rise.

Flexion of the Knee: The subject was in a prone position with arms above the head. A rise similar to that on the test for flexion of the hip was found except that there is a leveling off between 145 and 180 degrees. Again, increased strength was exerted when the muscles were on greater stretch. The leveling off at the top of the curve may be accounted for by unsatisfactory leverage as the knee reached a straightened position. This phenomenon did not occur in tests of flexion of the hip, possibly because the movement of the joint was not tested beyond 90 degrees.

Forward Flexion of Shoulder (fig. 6): The subject was in a supine position with the hips and knees flexed, the feet resting on the table and the free arm on the chest. The arm of the shoulder being tested was adducted to 180 degrees, and the elbow was in thrust position. A plateau extended from 90 to 135 degrees, the effect of the muscles being about the same through this range. The reduced power of the extensor muscles of the shoulder girdle may be seen as the arm extended forward overhead.

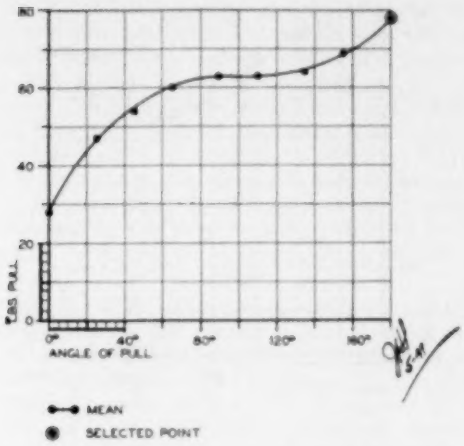

Fig. 6. — Muscle power exerted during forward flexion of the shoulder.

Abduction of Shoulder: The subject was in a supine position, with the hips and knees flexed, the feet resting on the table and the free arm on the chest. The arm of the shoulder being tested was adducted to 180 degrees with the arm close to the body, where the shoulder abductor muscles were on greatest stretch. The resultant curve of strength was similar to the preceding one: The height was at 180 degrees; the plateau, from 90 to 135 degrees. As the arm extended sideward overhead, the weaker scapular rotators became less and less effective.

Descending Curves. — Two of the joint movements, extension of the elbow and extension of the hip, had descending strength exhibited by descending curves. Both of them exhibited plateaus but in different positions on the graphs.

Extension of the Hip (fig. 7): The subject was in a supine position with free knee flexed, foot on table and arms folded on chest. Thigh being tested was adducted to 180 degrees. Again, greatest strength was exerted when the hip was fully flexed, with the muscles tested being at their full length. The plateau in this instance was at the end of the test, and was partly due to the increased effect of the weight of the leg on test scores as it straightened out. The power of the extensors of the hip was great indeed, the average for the subjects tested being 186 pounds (84.4 Kg.).[4]

Extension of the Elbow: The subject was in a supine position with the hips and knees flexed, the feet resting on the table and the free arm on the chest. The arm of the shoulder being tested was adducted to 180 degrees; the elbow was in 90 degrees of flexion, and the forearm was in midprone-supine position. The strongest position for movement of this joint was with the elbow fully flexed, when the muscles were on greatest stretch. The plateau was from 80 to 140 degrees, followed by some dropping off as the elbow straightened and the advantage of leverage was lost.

Ascending-Descending Curves. — Four of the tests yielded ascending-descending curves. The curves started at a low point at one end, rose to a maximal height in the middle and descended to a low point at the other end.

4. Direct comparison of pounds of pull for the various tests reported is not possible because of the unequal effect of gravity in the test positions.

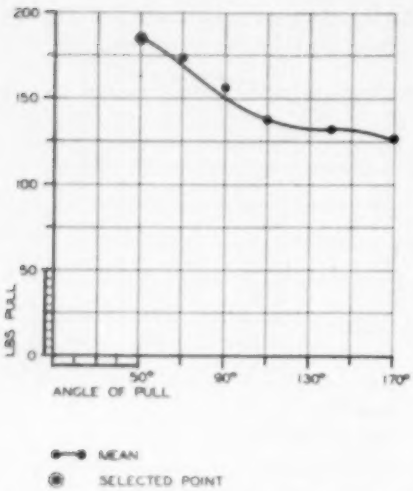

Fig. 7. — Muscle power exerted during extension of the hip.

Flexion of Elbow (fig. 8): The subject was in the supine position with the hips and knees flexed, the feet resting on the table and the free arm on the chest. The arm of the shoulder being tested was adducted to 180 degrees with the elbow in 90 degrees of flexion and the forearm in midprone-supine position. Again, a plateau existed at the strongest position for pulling, 100 to 140 degrees. The low point of strength was at full flexion of elbow,

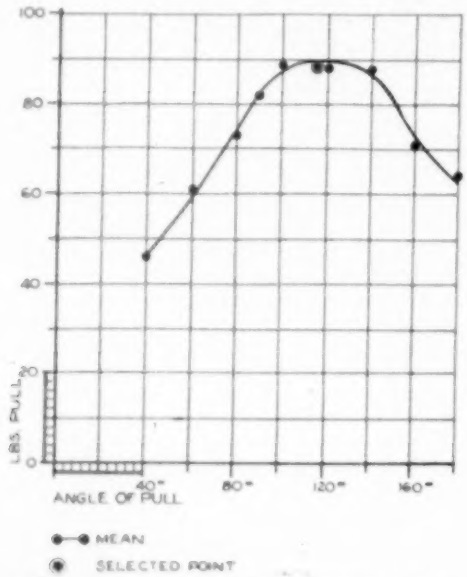

Fig. 8. — Muscle power exerted during flexion of the elbow.

where muscles are at a disadvantage because of less of tension. At full extension, the muscles are at greatest stretch, but the leverage is poor.

Adduction of Shoulder: The subject was in the supine position with hips and knees flexed, the feet resting on the table and the free arm on the chest. The arm being tested was extended to 180 degrees with the elbow in complete flexion. The graph representing strength was nearly symmetrical from 25 degrees to 180 degrees. A slight plateau between 90 and 110 degrees was apparent. Greatest power, therefore, was exhibited when the arm was at right angles to the shoulder. The adductors of the shoulder are at a disadvantage owing to loss of tension when the arm is close to the side of the body, and the weaker scapular rotators are evident as the arm pulls from an overhead position.

Extension of the Shoulder: The subject was in the supine position with the hips and knees flexed, the feet resting on the table and the free arm on the chest. The arm of the shoulder being tested was adducted to 180 degrees; the elbow was in 90 degrees flexion, and the forearm, in the midprone-supine position. Only relatively small changes occur throughout the range of motion of this joint: from a low of 59 pounds (26.8 Kg.) at 180 degrees to a height of 78 pounds (35.4 Kg.) at 65 degrees, a difference of only 19 pounds (8.6 Kg.). The variance between 45 and 135 degrees is only 6 pounds (2.7 Kg.), 72 to 78 pounds (32.7 to 35.4 Kg.).

Extension of the Knee: The subject was in a sitting position, leaning backward with the arms extended to the rear, the hands grasping the sides of the table and the legs hanging free. The thigh of the leg being tested was adducted to 180 degrees. The plateau for this movement of the joint was from 105 to 125 degrees, the high point of the curve. The low point was at full extension, 180 degrees. At the opposite point, full flexion, the muscles were on greatest stretch, but, although they pulled well, they appeared to be at a mechanical disadvantage.

Conclusions

These studies provide objective evidence for the statement that, other factors being equal, a muscle exerts its greatest power when it functions at its greatest tension; that the angle at which the muscle pulls is of importance but probably not of as great importance as the tension; that there probably is an optimal position at which each muscle functions best, and that this position may be one in which the tension is optimal (not necessarily maximal) and in which the angle of pull provides for the greatest rotary force.

Stabilizing force, or the force exerted parallel to the long axis of the bone, of course, is not measured in this study; but in some positions, such as full extension of the knee, this force may be considerable and in addition to the rotary component measured.

These studies point out only a few problems which need further study in regard to muscle function from a mechanical standpoint. There is still great need for standardization of positions for testing the strength of muscles and an even greater need for an adequate measuring device which will measure a wide range of power.

Acknowledgements are made to Theodore L. Bailey, research laboratory supervisor, and the following graduate students in physical education at Springfield College, who assisted in the collection of test data and in the statistical computations necessary for the studies reported and others completed in orthopedic strength testing under subsidy from the Office of Naval Research: James L. DePasquale; Dean U. Harrell; Paul B. Kirkland; Donald K. Mathews; Henry J. Pilote, *Jr.*; Edwin H. Richardson; Arthur R. Troisi, and Nicholas F. Troisi, Jr.

OBJECTIVE RECORDING OF MUSCLE STRENGTH *

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Before objective procedures for muscle testing are considered, it would be appropriate in this preliminary report to make a general survey of manual muscle testing. After the work is complete, an appraisal of the various methods of muscle testing can be made.

Fundamentals in Muscle Testing

Muscle testing should be an integral part of physical diagnosis; it is the basis on which the differential diagnosis, the individual needs for the specific therapy and the prognosis of muscular and neuromuscular disorders depend. Muscle testing is indispensable for an accurate analysis of muscle function.

Muscle weakness is an important feature which characterizes neuromuscular disease. The decision regarding the surgical intervention for fascial or muscle transplants should be based on evaluation of the strength of the muscles under consideration. In fact, any treatment of the muscles involved should be prescribed in the light of the findings, if reliably obtained.

As it stands today, manual muscle testing is an individualistic procedure, depending mainly on the skill, knowledge and experience of the examiner. Many factors, personal and otherwise, significant or insignificant, may alter the findings of the test in such a way that they may be misleading in an optimistic or a pessimistic manner.

An important requirement for reliable muscle testing is not only an accurate and detailed understanding but also a mastery of the functional anatomy of muscles. This implies sound knowledge of both the anatomy and physiology of muscle in a well coordinated manner. Having an excellent mastery of the origin, insertion, nerve supply and action of muscle is not adequate. Morphology should go hand in hand with physiology.

It must be emphasized that in every voluntary muscular act not only one muscle is working but several muscle groups act together as a unit. The following four groups of muscles are concerned in the performance of a voluntary act and normally act together as a unit: 1. Prime movers, or agonists, are those on whose contraction the movement of the part is essentially dependent. 2. Antagonists are the muscles whose contraction opposes that of the prime movers. 3. Synergists assist the prime movers and prevent the occurrence of practically all unnecessary movements. 4. Fixation muscles are those whose contraction stabilizes neighboring joints and puts the part into the most appropriate position for performing that particular act.

The examiner should be able to locate the belly of the muscle, to dis-

* Read at the Twenty-Seventh Annual Session of the American Congress of Physical Medicine, Cincinnati, Sept. 8, 1948.

tinguish between normal and atrophied muscles and to recognize displacements and abnormalities in position and appearance. In determining the level of a peripheral nerve lesion, one can be guided by the fact that weakness and atrophy appear in the muscles supplied by nerve branches distal to the lesion. An evaluation of the rate and degree of return of the muscle power obtained by repeated muscle tests provides an excellent index of the prognosis, but an accurate objective procedure would make a valuable supplement.

Manual muscle testing consists of two fundamental components: (1) test performance and (2) evaluation of muscle strength. In this type of testing, muscle grades are supposed to express objectively the examiner's evaluation of the functional strength of the muscle. Muscle grading is believed to be a functional evaluation of the strength of the muscle under examination. On paper, this sounds very simple and objective. However, how could it be objective when it is done without instrumentation and is based on certain gravitational factors in addition to the subjective feeling of the examiner and the resistance and power of the patient? In the picture of muscle weakness and evaluation of the return of strength, many factors are involved. No one single factor can possibly be used as the criterion for determining the grade of strength.

Weakness may be caused by (1) nerve involvement, (2) disuse atrophy, (3) pain, (4) fatigue or (5) irritation and pain on stretch. Similarly, several factors contribute toward the return of strength: (1) recovery from the disease process, (2) return of nerve impulse after a successful nerve suture, (3) exercise causing hypertrophy of muscles and overcoming disuse atrophy and (4) disappearance of the pain that used to occur on stretch or strain of the muscles.

In most instances of muscle testing, individual muscles cannot be evaluated. In addition to the overlap in muscle actions, movement, as stated previously, is carried out by allied muscle groups. This makes individual muscle evaluation very difficult. Furthermore, the loss of function of one muscle brings into action other muscles to accommodate for the lost function by substitution. Muscles that are closely related in position are the ones that usually act in substitution and stabilization during muscle testing.

The position of the patient is very important in muscle testing. For the muscle in which gravity is to be a factor in testing, the position of the part should permit action against gravity.

Fixation is another important factor. It refers to the stability of the body or part being tested and is essential for securing an accurate test. Fixation implies holding firm; it includes stabilization or immobilization of the joint or joints over which the muscles act. Fixation is obtained by the action of other muscles (fixators), by the position of the patient, by the examiner or by more than one of these factors. Firmness of the examining table contributes greatly toward good fixation of the body and aids in giving an accurate muscle test. In certain instances a solid, hard table is necessary for proper support of the body and is essential for obtaining accurate data. In our studies we found that by putting the subject on a hard table which was made firm by binding it to the wall with chains and by placing a footboard to support the feet and prevent the body from sliding, a much higher record of normal muscle power was obtained. Table 1 gives a set of data comparing the power of the same muscle group with and without foot support. Before the table was firmly fixed to the wall the subjects became apprehensive when it moved. This divided their attention and led to lower records of muscle strength.

During muscle testing one occasionally finds that a muscle group does not complete the normal range of joint motion. It is not always correct to conclude that the muscles are too weak to execute the movement to completion. Muscle weakness must be distinguished from limitation of range of motion.

TABLE 1. — *Comparison of Force of Elbow Flexors With and Without Use of a Foot Support.*

Force with Foot Support, Pounds	Force Without Foot Support, Pounds	Difference, Pounds
91	61.5	—29.5
114	74	—40
116	92	—24
100	84.5	—15.5
87.5	72.5	—15
121.5	100	—21.5
109	46	—63
88	55	—33
107.5	98	— 9.5
117.5	88	—29.5
Average 105.2	77.15	—28.05
	Standard deviation	= 15.3
	Standard error	= 4.7
		t = 6.0

Occasionally in the presence of relaxed, unstable joints, it is difficult to judge the degree of actual muscle weakness. Muscles appear very weak if the joints are extremely unstable.

The direction of pressure and the place where pressure is applied are as important as position in muscle testing. With few exceptions, pressure is applied to the distal end of the part where the muscle is inserted. The principle of leverage must also be observed in muscle testing. If the examiner does not apply pressure at a point where he has the advantage of leverage, the muscle test may indicate his strength rather than that of the patient.

Systems of Muscle Testing

Using gravity resistance as an objective measure for grading muscle strength, Lovett[1] introduced his method of muscle testing. The Lovett system forms the basis of grading in manual muscle testing. Most present day procedures used in muscle testing are modifications of the Lovett system. The system adopted by the Committee on After Effects, National Foundation for Infantile Paralysis, shown in table 2, is most commonly used.[2]

In certain muscle tests there is no need for the use of the gravity factor. For instance, it need not be used in testing either finger or toe muscles. The weight of a finger or a toe is so small as compared with the strength of the muscle that the role of gravity over such a part can be considered insignificant. Pronators and supinators of the forearm and facial muscles also can be tested without including the gravity factor.

The grading of very weak muscles is often in part dependent on palpation of the muscles tested. Therefore, certain weak muscles which cannot be adequately palpated may be erroneously graded.

The use of gravity-eliminated position has been recommended for a few tests. This has been done especially in cases in which an objective grade of

1. Lovett, R. W.: The Treatment of Infantile Paralysis, ed. 2, Philadelphia, P. Blakiston's Son & Co., 1917, p. 136.

2. Daniels, Lucille; Williams, Marian, and Worthingham, Catherine: Muscle Testing; Technics of Manual Examination, Philadelphia, W. B. Saunders Company, 1946, p. 11.

"poor" was sought in the case of muscles on which the antigravity test, because of severe muscle weakness, could not be easily graded.

Attempts have been made to grade by percentage. In the grading on the percentage basis between 10 and 40 per cent, the Kendalls[3] have recommended subjective measurement of the patient's assistance in the test movement. The part is relaxed so that the examiner can feel its weight. The patient then attempts to move the part against gravity, and the examiner subjectively estimates the amount of weight the patient takes by evaluating the decrease in weight of the part during the test movement. Table 3 gives the percentage grades for the various states in which the muscle is found.

TABLE 2. — *Revised System of Muscle Testing and Grading.*

100%	5		N	Normal	Complete range of motion against gravity with full resistance
75%	4		G	Good*	Complete range of motion against gravity with some resistance
50%	3		F	Fair*	Complete range of motion against gravity
25%	2		P	Poor*	Complete range of motion with gravity eliminated
10%	1		T	Trace	Evidence of slight contractility; no joint motion
0	0		0	Zero	No evidence of contractility
	S	or	SS	Spasm	Spasm or severe spasm
	C	or	SC	Contracture	Contracture or severe contracture

* Muscle spasm or contracture may limit range of motion. A question mark should be placed after the grading of a movement that is incomplete from this cause.

By placing the part in the antigravity test position, it can be noted that a muscle whose grade is less than 50 per cent cannot hold the part in that position. The gradual release from test position is graded 40 per cent. A 50 per cent muscle holds the test position against gravity. Grades of 60 per cent or more indicate ability of the muscle to hold the test position against gravity and against pressure by the examiner. Estimation of the amount of pressure applied by the examiner is subjective, no matter how well trained an examiner may be or how objective some muscle testers try to make it. Gradual application of pressure by the examiner helps to grade a muscle but does not necessarily make the grading objective as some claim. The ability of the muscle to hold against a minimal amount of pressure is graded between 60 and 70 per cent; against medium pressure between 80 and 90 per cent, and against maximal pressure, 100 per cent. The part whose muscles are being tested and the size of the patient influence the degree of pressure applied by the examiner.

"Normal" in the grading system of muscle testing connotes a muscle sufficiently strong to take the weight of the part against gravity and maximal resistance. For most muscles, however, "normal" indicates a 100 per cent strength.

In order to avoid some of the disadvantages of subjective methods of muscle testing, attempts have been made to use objective means for determining the strength of muscles.

Haxton[4] recorded the muscle power in the plantar flexors of the foot by means of a spring balance. The high internal resistance of the apparatus,

3. Kendall, H. O., and Kendall, F. M.: Muscles, Testing and Function, Baltimore, Williams & Wilkins Co., 1949, p. 7.
4. Haxton, H. A.: Absolute Muscle Force in the Ankle Flexors of Man, J. Physiol. 103:267 (Dec.) 1944.

the changing sensitivity of spring systems and the inability to record maximal contractions are apparent disadvantages of this method. Duvall and her coworkers[5] studied muscle strength with the hand dynamometer and found that it was a reliable tool for measuring grip strength.

Newman[6] has devised a "myometer" which has the advantage of compactness. One apparent disadvantage is the application of a counterforce by the examiner. One of the most detailed studies of muscle force was made by Clarke[7] by use of the cable tensiometer. The magnitude of the muscle force applied to the cable was determined by measuring by means of the tensiometer the tension in a taut cable. The purpose of this series of observations was to study power of one group of muscles objectively by means of the strain gauge and to compare data obtained by means of the strain gauge with data obtained simultaneously with the tensiometer under the same conditions. The strain gauge is of value because of the very low internal resistance of the recording system.

TABLE 3. — *Key to Muscle Grading on Percentage Basis.*

Class I* Finger and Toe Muscles Supinators, and Pronators.	Grade Per Cent	Class II† Wrist, Elbow, Shoulder, Ankle, Knee, Hip and Neck Muscles.
No contraction felt in muscle No movement of part	0	No contraction felt in muscle No movement of part
Feeble contraction felt in muscle Tendon becomes prominent during contraction No apparent movement of part	5 & 10	Feeble contraction felt in muscle Tendon becomes prominent during contraction No apparent movement of part
Part moved through small arc	20	Moderate assistance by examiner
Part moved through moderate arc	30	Slight assistance by examiner
Part moved through complete arc	40	Cannot hold test position against gravity; release very gradual
Muscle moves part through complete arc and holds test position	50	Muscle holds antigravity test position and moves part through complete arc
Holds test position against minimal pressure	60 & 70	Holds antigravity position against minimal pressure
Holds test position against medium pressure	80	Holds antigravity position against medium pressure
Holds test position against maximal pressure	100	Holds antigravity position against maximal pressure

* No gravity factor involved in grading. † Grading dependent on gravity factor.

Methods

Apparatus. — In all the observations, a strain gauge was used to measure the strength of the musle contraction. Of the four elements of the strain gauge, two were attached to the outside and two to the inner side of an aluminum alloy ring, approximately 4 cm. in diameter and 2.6 mm. in thickness. The ring was connected at one end to a steel cable, 1.75 mm. in diameter, attached to a sling into which the extremity to be tested was inserted. The other end of the ring was hung on a hook firmly attached to the wall. Changes of resistance in the strain gauge produced deflections of the galvanometer, which were recorded photographically.

In 200 observations, simultaneous readings of muscle power were taken under the same conditions by use of both the strain gauge and a cable tensiometer[7] (A-C type C-5; Pacific Scientific Company) with its maximal pointer in operation.

5. Duvall, Ellen N.; Houtz, Sara J., and Hellebrandt, F. A.: Reliability of a Single Effort Muscle Test, Arch. Phys. Therapy **28**:213 (April) 1947.
6. Newman, L. B.: A New Device for Measuring Muscle Strength: the Myometer, Arch. Phys. Med. **30**:214 (April) 1949.
7. Clarke, H. H.: Objective Strength Tests of Affected Muscle Groups Involved in Orthopedic Disabilities, Research Quart. **19**:118 (May) 1948.

Procedure. — All tests of muscle power were done with the subject in the recumbent position on a plinth which was firmly fixed to the wall. Flexion of the right forearm at the elbow was studied with the forearm in supination, the arm adducted and in neutral position. To prevent slipping of the subject on the plinth during the test, a footboard was attached to the table. In 10 observations, muscle strength was studied both with and without the use of the footboard. In most of the observations the forearm was placed in the sling whose proximal margin was 12 cm. from the olecranon. In 38 observations this distance was increased to 16 cm.

The angle at the elbow was varied, and observations were made at 10 degree intervals from 60 to 120 degrees. In order to maintain a perpendicular relation between forearm and cable, the strain gauge was shifted to hooks at different levels as the angle at the elbow was changed.

Data were collected on 20 young women and 4 young men who were considered normal. Since two or three angles were studied successively, the sequence which was followed was changed regularly so that no one angle would consistently be the first to be used. Furthermore, in order to minimize the fatigue factor, the number of contractions at one angle during one period of observation was never more than two, and the number of angles studied during that period was never more than three.

Results

Effect of Footboard on Muscle Power (table 1). — Comparison of muscle power in forearm flexion was made with an angle of 100 degrees at the elbow with and without the use of the footboard (10 observations on 4 young men). The average pull of the forearm flexors in the presence of the footboard was 105.2 pounds, while without the footboard it was only 77.15 pounds. The muscle power was greater with the footboard in every instance. The average difference in pull with the two technics was 28.05 pounds, with a range from 9.5 to 63 pounds.

Comparison of Strain Gauge and Tensiometer (table 4). — Simultaneous readings were taken with the two instruments, at angles of pull of 90, 100, 110 and 120 degrees (200 observations on 20 young women). The average power recorded with the strain gauge was 61.1 pounds, whereas with the tensiometer it was 57.0 pounds. The average difference in readings between the two instruments was 4.1 pounds, with the strain gauge giving higher results in 183 observations, the tensiometer giving higher readings in 10, and the two giving identical recordings in 7. Since the two instruments gave identical readings under static conditions, it seemed as if the lower results with the tensiometer were due to friction within the instrument.

Repeated Tests on the Same Subject (table 5). — The muscle power of elbow flexors was studied with the forearm supinated, with an angle of 100 or 110 degrees at the elbow and a distance of 12 cm. from the elbow to the sling (20 young women, 120 observations; 4 young men, 38 observations). Each figure giving muscle power indicated in the table represents an average of 6 observations for each woman, 10 observations for 3 men (subjects 21, 22 and 24) and 8 observations for the fourth subject, 23.

The average muscle power for the women was 62.2 pounds at 100 degrees, with a range from 44.6 to 76.3 pounds, and 60.2 pounds at 110 degrees, with a range from 43.1 to 77.3 pounds. In 16 of the 20 women the power was greater at 100 degrees than at 110 degrees, while in 4 the power was greater at 110 degrees. The variability for any one subject was small. The lowest variability occurred in subject 17, with a standard deviation of 0.8 pound (1.5 per cent of the average), whereas the greatest was present in subject 13 with a standard deviation of 7.2 pounds (11.6 per cent of the average value).

For the men the average muscle power was 101.3 pounds at 100 degrees, with a range from 92.0 to 111.5 pounds, and 100.5 pounds at 110 degrees, with a range from 91.4 to 109.9. In 3 of the 4 men, the pull was greater at 100 than at 110 degrees. The smallest standard deviation was 5.3 pounds

(5.3 per cent of the average), whereas the greatest was 8.5 pounds (9.3 per cent of the average).

Influence of Angle at the Elbow on Muscle Power. — Thirty-five observations were made on 14 women, with the elbow angle at 90, 100 and 110 de-

TABLE 4. — *Comparison of Strain Gauge and Cable Tensiometer Records of Muscle Power.*

	Average of 200 Observations
Strain gauge, pounds	61.1
Tensiometer, pounds	57.0
Difference, pounds	4.1
Standard error of difference, pounds	0.2
t	20.5

grees. The distance from the elbow to the sling on the forearm was 12 cm. The average power of forearm flexors in pounds was 67.0 ± 11.2 (figures following average values represent the standard deviation) at 90 degrees, 63.1 ± 8.2 at 100 degrees and 58.8 ± 8.0 at 110 degrees (table 6). The average power at an angle of 90 degrees was 3.9 pounds greater than at 100 degrees. The standard error of this difference was 0.9 pound. At 100 degrees the

TABLE 5. — *Force of Contraction of Elbow Flexors at Angles of 100 and 110 Degrees at the Elbow and a Resistance Arm of 12 cm.*

Subject	100 Degrees			110 Degrees		
	Average, Pounds	S. D.,* Pounds	S. E.,† Pounds	Average Pounds	S. D.,* Pounds	S. E.,† Pounds
			Female			
1	73.7	4.1	1.7	77.3	5.8	2.4
2	76.3	3.0	1.2	71.7	5.7	2.3
3	72.6	4.4	1.8	73.5	6.4	2.6
4	73.5	4.4	1.8	70.7	2.7	1.1
5	68.1	4.7	1.9	66.3	5.1	2.1
6	65.7	3.6	1.5	62.1	4.6	1.9
7	64.2	3.0	1.2	62.2	2.2	0.9
8	62.8	2.0	0.8	61.9	3.7	1.5
9	62.3	6.1	2.5	60.5	3.7	1.5
10	61.8	2.5	1.0	62.2	5.2	2.1
11	62.4	3.1	1.3	59.9	2.9	1.2
12	62.3	4.7	1.9	59.3	3.1	1.3
13	61.8	7.2	2.9	55.6	5.5	2.2
14	60.2	2.7	1.1	59.5	2.8	1.1
15	57.8	4.1	1.7	53.2	5.2	2.1
16	56.0	2.9	1.2	53.6	4.0	1.6
17	52.9	3.2	1.3	54.3	0.8	0.3
18	52.5	2.3	0.9	49.7	4.9	2.0
19	51.5	5.1	2.1	47.7	8.8	3.6
20	44.6	3.0	1.2	43.1	2.9	1.2
Average	62.2	—	—	60.2	—	—
			Male			
21	111.5	6.5	2.1	109.9	8.5	2.7
22	103.4	6.7	2.1	100.8	8.0	2.5
23	98.2	7.1	2.5	100.0	5.3	1.9
24	92.0	6.0	1.9	91.4	8.5	2.7
Average	101.3	—	—	100.5	—	—

* Standard deviation. † Standard error.

average muscle power was 4.3 pounds greater than at 110 degrees with a standard error of 1.1 pounds for this difference. In 25 observations the muscle power was greatest at 90 degrees, in 7 it was greatest at 100 degrees and in 3 it was equal at 90 degrees and at 100 degrees.

Another series of 22 observations was made on 14 women, comparing the pull at angles of 100, 110 and 120 degrees. The distance from the elbow

to the sling was 12 cm. The average pull, in pounds, was 60.5 ± 10.4 at 100 degrees, 56.6 ± 9.9 at 110 degrees and 50.5 ± 10.5 at 120 degrees. At 100 degrees, the muscle power was 3.9 pounds greater than at 110 degrees, with a standard error of the difference of 1.0 pound. The power at 110 degrees

TABLE 6. — *Effect of Varying the Angle at the Elbow on the Power of Elbow Flexors.**

	Angle of Pull			Mean Difference, Pounds	Standard Error, Pounds	t
	90°	100°	110°			
Average muscle force, pounds	67.0	63.1	58.8	—	—	—
Comparison, 90 and 100°	—	—	—	3.9	0.9	4.3
100 and 110°	—	—	—	4.3	1.1	3.9

* Distance from point of pull to elbow was 12 cm.

was 6.1 pounds greater than at 120 degrees, with a standard error of the difference of 1.3 pounds. In 16 of the 22 observations, the greatest pull was at 100 degrees; in 5 the greatest pull was at 110 degrees, and in only 1 the power was the same at 100 and 120 degrees (table 7).

The data for all muscle power studies done with a resistance arm of 12 cm. are summarized in table 8. Muscle power was greatest when the angle

TABLE 7. — *Effect of Varying the Angle at the Elbow on the Power of Elbow Flexors.**

	Angle of Pull			Mean Difference, Pounds	Standard Error, Pounds	t
	100°	110°	120°			
Average muscle force, pounds	60.5	56.6	50.5	—	—	—
Comparison, 100 and 110°	—	—	—	3.9	1.0	3.9
110 and 120°	—	—	—	6.1	1.3	4.7

* Distance from point of pull to elbow was 12 cm.

at the elbow was 90 degrees and least when the angle was 120 degrees.

Two series of observations were made with the distance from elbow to sling increased to 16 cm., and the muscle power was studied at intervals of 10 degrees from 60 to 100 degrees. In one series (20 observations on 20

TABLE 8. — *Effect of Varying the Angle at the Elbow on the Power of Elbow Flexors.**

Angle at elbow, degrees	90	100	110	120
Average muscle power, pounds	67.0	62.1	57.7	50.5

* Distance from point of pull to elbow was 12 cm.

women) muscle power was compared at elbow angles of 80, 90 and 100 degrees, respectively, and in the other series (18 observations on 9 women) at angles of 60, 70 and 80 degrees. In the first group (table 9) the average power was 56.0 ± 9.4 pounds at 80 degrees, 56.2 ± 7.6 pounds at 90 degrees

TABLE 9. — *Effect of Varying the Angle at the Elbow on the Power of Elbow Flexors.**

	Angle of Pull			Mean Difference, Pounds	Standard Error, Pounds	t
	80°	90°	100°			
Average muscle force, pounds	56.0	56.2	53.8	—	—	—
Comparison, 90 and 100°	—	—	—	2.4	1.0	2.4
80 and 90°	—	—	—	0.2	1.6	0.1

* Distance from point of pull to elbow was 16 cm.

and 53.8 ± 8.7 pounds at 100 degrees. The power at 90 degrees was 2.4 pounds greater than at 100 degrees, with a standard error of the difference of 1.0 pound. There was a difference of only 0.2 pound between the power of contraction at 80 degrees and that at 90 degrees. In 7 observations the muscle power was greatest at 80 degrees, in 7 at 90 degrees and in 4 at 100 degrees; in 1 it was the same at 80 and 90 degrees, and in 1 it was the same at 80 and 100 degrees. In the second group (table 10), the average muscle power was 51.3 ± 8.5 pounds at 60 degrees, 53.9 ± 7.3 pounds at 70 degrees and 56.1 ± 7.1 pounds at 80 degrees. The power at 80 degrees was 2.2 pounds

greater than at 70 degrees, with a standard error of the difference of 0.8 pound. The power at 70 degrees was 2.6 pounds greater than at 60 degrees, with a standard error of the difference of 1.1 pounds. In 12 observations the muscle power was greatest at 80 degrees, in 4 at 60 degrees and in 1 at 70 degrees, while in 1 the power was the same at 70 and 80 degrees.

TABLE 10. — *Effect of Varying the Angle at the Elbow on the Power of Elbow Flexors.**

	Angle of Pull			Mean Difference, Pounds	Standard Error, Pounds	t
	60°	70°	80°			
Average muscle force, pounds	51.3	53.9	56.1	....	....	....
Comparison, 70 and 80°	....	....	....	2.2	0.8	2.8
60 and 70°	....	....	....	2.6	1.1	2.4

* Distance from point of pull to elbow was 16 cm.

The data for all observations made with a resistance arm of 16 cm. are summarized graphically in the chart. It indicates that optimal power of elbow flexors is obtained at an angle between 80 and 90 degrees.

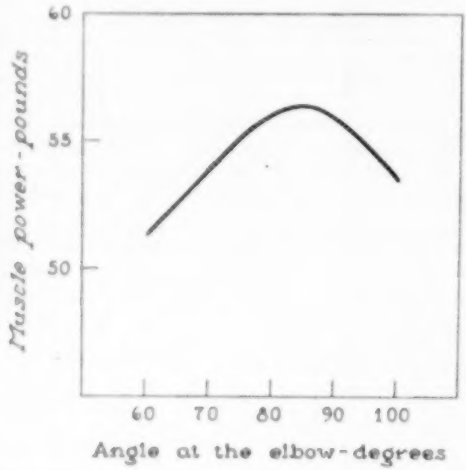
In table 11, the effect of varying the distance from the elbow to the point of pull on muscle power in the elbow flexors is given. When the angle at

TABLE 11. — *Effect of Varying the Distance Between Point of Pull and Elbow on the Power of Elbow Flexors.*

Angle at Elbow, Degrees	Muscle Power in Pounds with Distance from Elbow at		Mean Difference, Pounds	Standard Error of Mean Difference, Pounds	t
	12 cm.	16 cm.			
90	67.0 ± 10.1*	56.2 ± 7.7	10.8	2.4	4.5
100	62.1 ± 9.2	53.8 ± 8.5	8.3	2.2	3.8

* ± Figures represent standard deviation from the mean.

the elbow is 90 degrees, muscle power is 67.0 ± 10.1 pounds with a distance of 12 cm., and 56.2 ± 7.7 pounds with a distance of 16 cm., from the elbow to the sling. When the elbow angle is 100 degrees, the muscle power is 62.1 ±



The influence of varying the angle at the elbow on the power of forearm flexors with the point of pull at a distance of 16 cm. from elbow.

9.2 pounds with a resistance arm of 12 cm. and 53.8 ± 8.5 pounds with a resistance arm of 16 cm. At both angles, the muscle power recorded is significantly decreased when the sling is moved farther from the elbow.

Summary

The force of contraction of normal forearm flexors (in supination) was studied by means of the strain gauge, which provides a reliable objective method for the testing of these muscles. Repeated observations over a period of weeks indicated that there was only slight variation in muscle power for any one individual. The greatest variation recorded

$$\frac{(\text{standard deviation} \times 100)}{\text{average value}}$$

was 11.6 per cent for the women and 9.3 per cent for the men. The smallest variation for a single subject was 1.5 per cent for the women and 5.3 per cent for the men.

The strain gauge gave higher readings than the cable tensiometer in 183 of 200 observations, the average difference being 4.1 pounds.

Muscle power was consistently greater when a footboard was used to stabilize the subject than when it was not used. The power averaged 28.05 pounds more in the presence than in the absence of the footboard.

Muscle power of the forearm flexors was greatest when the angle at the elbow was between 80 and 90 degrees, and declined when the angle was increased or decreased beyond this range.

With increase of the resistance arm (distance from fulcrum to the sling), the recorded muscle power decreased.

Discussion of Papers by Dr. H. Harrison Clarke, et al., and Dr. K. G. Wakim, et al.

Dr. Robert W. Boyle (Fort Thomas, Ky.): The strength of muscular contractions has been an experimental problem for many years. The biochemist, physiologist and physical educator has each made his contribution to the literature. From the clinical point of view the orthopedist, surgeon and physiatrist has also made his contribution. Still, as in all science, the reason that men keep working on the problem is because the answer is not complete. Probably the most outstanding reason why the answer is incomplete is that there has been no standardized method of measuring muscle strength. As Dr. Wakim has pointed out,instrumentation has been difficult to achieve.

The many variables in this problem as mentioned above are another source of worry; body position; effect of gravity; initial position of the muscle; the extensibility and elasticity of the muscle; the part played by the antagonist, synergist and the fixator. Add to these variables, the many neurons through which the voluntary impulse must travel before causing the muscle contraction and you have bitten off more than the average scientist can chew.

Now that we are all thoroughly confused, let us look for a moment at what it is that we desire to know about the strength of muscular contractions. First, we want to know whether the patient will have enough power to carry on the factors inherent in daily living. Second, will he have enough strength left from the above so that he can hold a job and earn a living. The answer to this latter question will depend entirely upon what kind of a job it is. We are well aware of the fact that a day laborer must be able to expend more energy than a stenographer.

Some industrialists have already begun to cope with this problem. They are measuring how much power is necessary to carry out a given task in their production line. When this is known and then we multiply that number by the number of repetitions that will be required per day, then we will know what to measure in the patient. DeLorme has labeled this as endurance, which he says is many repetitions of a low resistance exercise. So far, we have had to rely upon trial and error in deciding whether or not a patient would be able to carry out a given task.

The need for a sure fire method of testing muscular strength and endurance is great indeed for those of us who are working daily trying to prepare patients to meet the needs of life. It will only be with the persistence of such men as Dr. Wakim and Dr. Clarke that we may eventually find the method and means for measuring those properties of muscle which are so essential to the welfare and independence of our patients.

Dr. Sedgwick Mead (St. Louis): May I ask one question of Dr. Wakim? It is a question of terminology.

I notice Dr. Clarke uses the term "muscular power." In physics, power is the rate of doing work. I know that in common parlance we speak of a powerful man and

of estimations of power, but should we settle on a term which is as accurate in terms of physics as possible, and not have interchangeable terms such as power and strength?

Dr. Alexander Sandow (New York): I should like to ask whether the time of day, in terms of the state of nutrition of the patient, has anything to do with his muscular strength, and also whether it would be desirable to get, as a measure of muscular strength itself, the response of muscles to direct excitation, instead of depending on the patient's voluntary effort which involves indirect excitation. Finally, what is the value of electromyography in determining muscular strength?

Dr. Wakim (closing): To answer Dr. Sandow's question, of course, time of day has a great deal to do with muscular strength. You know that when a person is hungry or nervous, he cannot work very efficiently. Furthermore, when we are dealing with patients, their weakness and sickness make important additional factors for consideration.

Regarding electromyography, I don't know how useful it may be in the study of muscle strength. From the electromyographic point of view, the more strongly a muscle is contracting, the greater is the number of motor units in action. Electromyography is worth trying, but one has to be well aware of the many pitfalls in evaluating muscle strength quantitatively by depending on the electromyogram alone.

In answer to Dr. Mead's question. In clinical literature the words "strength" and "power" are used interchangeably in discussions of muscle strength. It is probably more accurate to use the word "strength" because it indicates "power that is inherent," while "power" is a more general term. It makes no difference to me what term is used, if we in the various fields have a clear understanding of the implication.

28th Annual Session

SCIENTIFIC EXHIBIT SPACE

Requests for applications for scientific exhibit space in connection with the 28th Annual Session to be held at the Hotel Statler, Boston, Massachusetts, August 28 to September 1, 1950, are being received. Address all communications to the American Congress of Physical Medicine, 30 North Michigan Avenue, Chicago 2.

PRACTICAL FOOT PROBLEMS *

JOSEPH E. BROWN, M.D.

CLEVELAND

Practical application of treatment implies eradication of the underlying etiologic factors whenever possible. Perhaps it would seem rather bold to say that such is not the case in the approach to foot discomfort, but in my experience as an orthopedic surgeon, with a deplorable degree of accuracy, such is the rule rather than the exception in the "foot problems" seen in daily consultation. The person with painful feet seeks advice from the laity and resorts to trying nationally advertised appliances, devices and shoes in greater numbers than the person with arthritis, the person with a chronic skin ailment or the balding male. This approach is hardly considered scientific and is doomed to failure. This fact is readily recognized by the success of the shoe manufacturer, the appliance and arch support maker and the chiropodist.

It has been estimated that one in three persons has a "foot problem" for which "something" has been or is being done. This "something" invariably resolves itself into self treatment with an appliance sold in the drug stores, a special type of shoe with "built in" features suggested by the shoe salesman or the deft treatment by the chiropodist, which in the case of the woman includes a pedicure with nail laquer. Interestingly, the vast majority of these problems are amenable to simple conservative treatment—this will be enlarged upon in the discussion of the specific conditions.

Why, then, is it that the shrewd, dollar-wise American continues to invest money so unwisely, to accumulate dozens of pairs of arch supports and to clutter up his closet with unwearable and often costly shoes?

Specific "practical foot problems" in the order of frequency of occurrence and age incidence are to be dealt with. These have been chosen with due consideration of the special interest of practitioners of physical medicine. Conditions not requiring the adjuncts of physical therapy and those specifically requiring surgery are omitted. To avoid the risk of confusion and boredom, an extensive classification is purposely eliminated. Treatment is to be stressed.

The importance of roentgen ray examination can not be stressed too greatly, especially weight-bearing views. The latter will serve well, enabling one to recognize developmental or structural insufficiencies as well as pathologic conditions and thus guide your treatment accordingly.

The Infant and Child

In the infant and child metatarsus primus varus, the "flatfoot" which is the foot in muscular imbalance (properly called talipes valgoplanus because it describes the condition anatomically), tibial torsion and genu varus or valgum are the conditions chosen for discussion because of their frequency of occurrence and improper supervision. Parents are concerned about their offspring and, if possible, would prefer to have the child avoid the trouble they may have had. Parents are not satisfied with a disinterested "don't you worry, he'll outgrow it."

Metatarsus primus varus is a developmental anomaly. Here the first metatarsal is distinctly adducted and carries with it the entire forefoot. Cor-

* Read at the Twenty-Seventh Annual Session of the American Congress of Physical Medicine, Cincinnati, Sept. 8, 1949.

rection should be instituted early, upon recognition, and before weight bearing. Gratifying response can be expected from manipulation and a series of plaster casts until the foot is "overcorrected"; this is followed by stretching, the wearing of a tarsopronation shoe and the use of "pigeon toe" or rotator straps when indicated. Failure to correct the condition may lead to hallux valgus, metatarsalgia and shortening and destroying longitudinal arch.

Congenital flat foot — pes valgoplanus — may be partially outgrown. These feet have a definite relation to future foot weakness and are not considered normal feet. As in the case of a clubfoot, the earlier the recognition and institution of treatment, the shorter the period of treatment and better the results. Thompson's application of the reverse Dennis-Brown splint is practical and efficient. At the walking age the child is fitted with sturdy shoes with a heavy sole. A medial heel lift, medial wedges of sole and heel and an oval or "cookie" under the sustentaculum tali may be necessary. As soon as the child is capable of cooperating, corrective exercises are begun. Supervision, supportive measures and exercises may have to be continued to maintain a normal-functioning foot. "As the twig is bent, so the tree is inclined."

Tibial torsion — internal torsion — is a failure of proper rotation of the tibia. The "pigeon-toed" child is the result of this failure to rotate and as such presents functional and cosmetic handicaps and often produces a psychologic disability. Abnormal torsion may also be seen in many pathologic conditions of the lower extremities; however, this consideration and discussion implies none of the more serious musculoskeletal conditions. It is responsive to derotation exercises, the use of the Dennis-Brown splint exerting a rotational stress opposite to the deformity, the use of the "rotator" strap and a wedge on the outer border of the sole of the shoe.

Genu varum or valgum demand that knee conditions be corrected as early as identified to avoid foot strain. This is accomplished by either outside or inside wedges as indicated. Frequently undesirable overcorrection is attained. This can be avoided by regulated supervision.

In the previously mentioned conditions specific corrective exercises are imperative. The child can be taught the exercises, but the responsibility of practicing them must be relegated to the parents. This is best accomplished not only by instructing the parents but by giving them illustrated forms to take home to study. Worthy of mention are the eversion exercises, rotation of the feet, supination board and walking board. The effectiveness of the treatment depends upon the continued enforcement of the basic principles instituted.

The Adolescent

In the teen age group, in addition to the holdovers of the infant and child category, flat foot or the painful everted foot, the splay foot — metatarsus latus — and prehallux — accessory scaphoid — are perhaps the most frequently encountered. The spastic flat foot is attracting more attention on the part of the orthopedic surgeon and warrants inclusion in the discussion.

It is felt appropriate to say that the cause of the flatfoot, as it is so commonly referred to, is muscular imbalance. This applies to the painful everted or pronated foot, for it is the foot strain that produces the symptoms and stimulates the patient to seek relief. The osseous component can be excluded by roentgen ray studies; the ligamentous component usually re-

quires a specific trauma; this implicates the only remaining component — the muscular. More specifically, this condition arises when the postural muscles of the longitudinal arch become unable to fulfil their function; this is a functional disorder of the foot. By the same token, the condition is referred to as a "statio deformity," because, save in the rigid flatfoot or the spastic flatfoot, the flattening of the arch is apparent only upon weight bearing; when these feet are raised from the ground the arch is restored. Harris uses the descriptive title "hypermobile flatfoot with short tendo achillis." The various types or stages of flatfoot gradually merge into one another. It is useful, from the treatment standpoint, to recognize this distinction, even though it is not a sharp one. Not all flat feet require treatment; the indications are pain and impaired function.

The objects of treatment are to correct the malalinement of the foot, restoring the normal center of gravity and transferring the body weight to the outside of the foot; to remove pressure symptoms, and to restore or increase the power of the musculature which motivates the foot and in particular those that support the arch. Failure to comply fully with all these objects results in partial, temporary or complete failure in the eradication of the symptoms. The "all or none" law is especially appropriate in the supervision of the flatfoot. These objects are accomplished by "proper shoeing," the use of corrections or modifications in the footwear, the use of arch supports and, most important, physical therapy and the corrective exercises.

In regard to the footwear, stylists dictate the type of shoe to be worn, manufacturers cater to their demands and unfortunately, in most instances, the style is contrary to the scientific requirements. Proper shoes are available, but not every community is served by a store carrying them in stock; this is a major stumbling block. It is imperative that the clinician have a keen understanding of the structure of satisfactory shoes in order to prescribe them. Shoe requirements vary, but one factor is constant: The shoe must be the right size for the foot. Ideally a shoe will allow the preservation of the shape of the foot; it will have a straight inner border, be wide enough to accommodate the metatarsals and have a round toe, a flexible but sufficiently hard and thick sole to protect the sole of the foot, a rigid shank, a stiff counter and a broad stable heel. If a foot is made to conform to the shoe, deformity results — in the foot.

Modifications of shoes, incorporation of corrective features, are in most cases only temporary measures to help nature restore the proper foot posture and to relieve pressure symptoms. A few of the ones more commonly employed are the wedge to elevate the border of the heel or sole, the Thomas or anatomic heel to extend the support anteriorly under the sustentaculum tali, the metatarsal bar or cleat — the so-called anterior heel — to remove pressure from the metatarsal heads. These measures are more direct and efficient than devices placed within the shoe.

Appliances within the shoe include arch supports and felt and sponge rubber pads. They are designed to relieve pressure or exert pressure as determined by the condition, providing relief from painful weight-bearing areas (usually metatarsal heads) or supporting the longitudinal arch. Arch supports are made from almost every conceivable material. Metal supports act like a crutch; their use is most limited. If necessary, the support should be of a resilent material. I prefer the elastic support. Any or all of the aforementioned corrections are successful only if supplemented by the various physical therapy procedures. In the acute painful stages massage, con-

trast and or whirlpool baths and electrical (faradic) stimulation affords speedy relief. Then the after-care, exercises, assumes the most important role. It would be superfluous to enumerate these, but repetition is necessary in order that the patient fully understands the actual execution of the exercises, the reason for the particular group of specific exercises and the importance of incorporating them in his daily routine. Too often the best result is not obtained because of failure of the patient to perform his part conscientiously and persistently. The muscle training must be continued for long periods. Improvement (relief of symptoms), usually results in relaxation on the part of the patient and precipitates recurrence of the foot strain. The patient must be duly impressed with their own importance — the responsibility relegated to them only after thorough planning of the regimen. They should be given something concrete to remember and study, viz., illustrated outlines.

De Lorme has advocated the principles of heavy resistive exercises. Even greater improvement in the results obtained by muscle exercises in the foot can be achieved by the application of his technics. No therapist should be guilty of the error of employing the wrong type or exercise to develop the quality needed in the muscle: Low-repetion, high-resistance exercises produce power; high-repetion, low-resistance exercises produce endurance.

The spastic flatfoot is unique in that it is a foot fixed in extreme eversion by spastic contraction of the peroneal muscles. The pathologic process is situated in the talonavicular or subtalar joints. The roentgenogram will usually reveal, even in young persons, rather marked hypertrophic changes in these joints. The conservative treatment is not uniformally agreed upon. I favor manipulation under anesthesia and the application of casts holding the foot in the inverted or supinated position. Walking irons may be applied to the casts. Upon their removal after six or eight weeks, a corrective shoe with a medial border wedge (heel and sole) is worn. Here, I feel, is one of the few instances for the use of a rigid metal support. It naturally follows that after the acute symptoms have subsided (rest and hydrotherapy induce relief) corrective exercises are instituted. The prognosis is by necessity guarded. Surgical intervention directed at the spastic peroneal muscles (pronators) is condemned. Ankylosing operations on the involved joints are the only sound surgical procedures.

Metatarsus latus, or splay foot, is a developmental variation. It is important primarily because of the difficulties encountered from its neglect. It predisposes the foot to plantar calluses, bunion formation, metatarsalgia and plantar introdigital neuromas. Its treatment consists in recognition and prescription of proper shoes, metatarsal support and exercises.

An accessory scaphoid likewise is a developmental anomoly. It is a resultant of a mechanical strain in poor balance that produces symptoms of pain and weakness in the longitudinal arch. Frequently the pressure of the bony prominence will result in an adventitious bursa. The conservative approach may well fail to bring about the desired relief, and surgery is indicated. Here again roentgenographic study prevents "fumbling" and justifies the proposed surgical measures.

The Adult

This paper is not intended to be all-inclusive, and the conditions chosen from this age group are the flexible flatfoot, metatarsalgia and the painful heel.

The flexible flatfoot of the adult may be a carry-over or, as is frequently the case, a recent development. It is the sequela of congenital anomolies,

muscular imbalance from a low capacity muscle or from the too great a load (obesity), excessive exercises in the unconditioned person, improper footwear and occupational fatigue. Treatment is the same as has been elaborated upon previously in the discussion of flat feet in the young person. More difficulty is encountered and expected in women especially in attempting to prescribe sensible shoes. Comfort is sacrificed for beauty in more than footwear.

Metatarsalgia is a symptom rather than a condition. Regardless of origin, most foot pain centers in the region of the metatarsal arch. The actual existence of an arch is equivocal. Disturbances in the arch are commonest in persons over 30 years of age and in women. They are more frequently unilateral than bilateral. Arthritis is an important etiologic factor. Roentgen ray studies are most necessary to rule out this and other complicated factors.

The callus formation that develops on the plantar surface of the foot and on the dorsum of the secondarily contracted toes is the object of most treatment, with little attention being focused on correcting the mechanical factor and relieving pressure, and almost complete disregard of the manipulation and stretching of the contracted capsules and use of exercises to restore the power of the supporting structures and the flexibility of the arch. Treatment consists in limited activity and hydrotherapy in the acute phase. Proper shoes with the insertion of metatarsal pads and metatarsal bars if necessary should be worn. The callus should be trimmed once and thereafter the horny localized thickening of the epidermis gradually eliminated by the use of a pumice stone. The elimination of pressure prevents recurrence. The patient is then instructed in foot exercises and given a mimeographed sheet for home study and reference. He is also taught how to manipulate the feet and stretch the contracted capsules. Contrast foot soaks have a stimulating effect and are included in the regimen. If this routine is religiously followed, the patient experiences complete comfort.

No discussion of metatarsalgia would be complete unless reference is made to interdigital plantar neuroma and metatarsal march (fatigue) fracture. Careful evaluation will identify the former; roentgenograms will prevent oversight of the latter. I hasten to add that neither condition will respond to physical therapy.

The painful heel is generally an unsatisfactory condition to treat. The causes of this severely disabling affliction vary from a bursitis, periostitis, osteitis, fibrositis (plantar fascia) and arthritis to actual calcaneal spur formation. The careful examiner has little difficulty in arriving at a definite opinion as to the existing pathologic process; the treatment is less easy.

Existing foci of infection must be eradicated. In acute cases complete bed rest is frequently required. I have found that paraffin baths are the most soothing form of physical therapy. Proper shoes with a calcaneal bar and soft sponge rubber pads, hollowed in the center, redistribute pressure. Procaine infiltration will give temporary relief by interrupting the reflex arc. Roentgen ray therapy will control a limited number of cases. Surgical removal of an existing spur is condemned. When the forementioned measures fail, denervation is indicated and is successful. Preliminary selective nerve blocks (the sural and posterior tibial nerves) although temporary, will allow the patient to appreciate the comfort of a numbed heel and enable him to anticipate the results of this dramatic surgical procedure.

In closing, because of the multiplicity of clinical entities discussed, no conclusions are to be arrived at, save the obvious importance of physical therapy in the treatment of practical foot problems.

Discussion

Dr. Walter M. Solomon (Cleveland): Several years ago I wrote what was intended to be an editorial on the feet for the ARCHIVES, attempting to show why the physcians are the most competent persons to care for the foot disorders. As a result, the Chicago office received several not too complimentary letters from chiropodists justifying their profession. My remarks were not directed at the many chiropodists who are excellent men, well educated and well trained and with whom the medical profession maintains an ethical and mutually beneficial relationship, but to those amongst their midst who fail to realize their limitations and, more pointedly, to those lay persons who sell too many metal plates and elastic supports to the anxious public as a cure-all for their aching feet. I also had in mind an equally avaricious group — the shoe manufacturers and shoe merchants who advertise their products as the solution for all the causes of foot pain. The number of these ugly and expensive shoes that are sold is tremendous. Of course, this is not news.

Part of the blame for this situation rests with ourselves. In most instances we certainly can find fault with our education in our medical school and hospital training. And later in our practices we become either too busy or indifferent, or both, to consider the specific problems of the feet. Fortunately, a few physcians, particularly orthopedists, have not been complacent and with intelligence and enthusiasm are attempting to correct and control this condition. It seems logical that a medical education supplying the knowledge of all the basic factors which influence the function of the feet will make it possible to arrive at the proper diagnosis and, in turn, to outline a rational and thorough method of treatment. This paper of Dr. Brown's gives evidence of what a thoughtful and accurate medical analysis of foot ailments can accomplish.

That much has been timed to take one and a half minutes; now in the other one and a half minutes allowed to discussion, I should like to recall the possibility of weak and pronated feet producing symptoms in the other parts of the body, particularly the knees and back. A good orthopedist from Boston in a survey of his private practice during seven years found 694 of his patients with knee symptoms and 478 patients with back pain, which he maintained were associated with weak or unbalanced feet and which he assumedly relieved by treating the strained feet. With feet that function poorly, the entire equilibrium of the body is disturbed. The knees may show internal rotation with overstretching of the internal lateral ligaments and straining of the muscles on the medial side, which, when long continued, can lead to degenerative changes of the knee joints. The compensatory mechanism of abduction, dorsiflexion and supination which occurs in the forepart of the foot resulting from strained feet is reflected in the back as well as in the knees. In order to maintain balance, the shoulders are brought backward, causing a forward tilting of the upper portion of the pelvis, producing a lumbar lordosis. This explanation is over simplified and is certainly not the only factor responsible for pathologic changes in the knees and back; however, by appreciating this relationship and taking measures to improve the pronated and weak feet, the faulty body mechanics may be partially corrected and thus aid in relieving those other structures.

ANNOUNCEMENT

A program on physical medicine will be presented in Bay City, Michigan, on Wednesday, April 26. The meeting is being arranged by Dr. Max Newman of Detroit. Details will appear in a later issue of the ARCHIVES.

ARCHIVES of PHYSICAL MEDICINE
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.·. EDITORIALS .·.

NEW AVENUES FOR RESEARCH IN PHYSICAL MEDICINE AND REHABILITATION

The possibilities for research in Physical Medicine and Rehabilitation are already great and have received considerable attention in past issues of the ARCHIVES. The close relation of the basic sciences of physics and physiology to Physical Medicine is obvious as indicated by numerous reports on subjects such as electromagnetic radiation, mechanics of motion and, more recently, ultrasound. Electrophysiology and the circulatory effects of physical agents have long been popular subjects for research by physiatrists. In the past, endocrinology has seemed to be rather distant from the sphere of activity of Physical Medicine and Rehabilitation, but it now appears that a new avenue is being opened to lead investigators in our field in that direction.

The dramatic effects in rheumatoid arthritis from administration of certain steroids of the adrenal cortex have started an avalanche of new interest in endocrine gland functions. It is now generally known that 17-hydroxy-11-dehydrocorticosterone (Kendall's compound E, or cortisone), 17-hydroxycorticosterone (compound F) and adrenocorticotrophic hormone (ACTH) of the pituitary may cause remissions in rheumatoid arthritis and related diseased of collagen metabolism. Hope for solution of the riddle of pathogenesis has been rejuvenated from the realization that the lesions are reversible, and the mechanism that starts and stops the well known clinical chain of events we call rheumatoid arthritis may be under our control in the not too distant future.

A recent summary of some established findings to date is worth noting.[1] A group of investigators from Philadelphia have shown, as have others, that rheumatoid arthritis, rheumatic fever, disseminated lupus erythematosus and dermatomyositis, or what we commonly speak of as the "group diseases" are temporarily reversed by stimulating the adrenal cortex to greater activity by administration of ACTH, a product of the pituitary gland, or by adrenal steroid compounds "E" and "F." Metabolic studies have shown that adrenal cortex function was increased by ACTH. These known functions include regulation of sodium and potassium excretion, stimulation of gluconeogenesis and inhibition of carbohydrate utilization, and the androgenic function leading to nitrogen and potassium retention and increased excretion of 17-ketosteroids. In spite of the successes obtained, failures and complications are being reported with increasing frequency. These include refractoriness to the drug, Cushing's syndrome, potassium deficiency, encephalopathy, unpleasant changes in secondary sexual characteristics and psychogenic disturbances. Much more work is needed before our goal can be reached.

Let us consider what bearing this may have on Physical Medicine and Rehabilitation. We have all seen occasional dramatic reversals of symptoms while receiving physical therapy, but have hesitated to connect the two caus-

1. Elkinton, J. R.; Hunt, A. D., Jr.; Godfrey, L.; McCrory, W. W. Rogerson, A. G., and Stokes, J., Jr.: Effects of Pituitary Adrenocorticotropic Hormone (ACTH) Therapy, J. A. M. A. 141:1273 (Dec. 31) 1949.

ally. May there not be, however, a possible effect of physical therapy which may have a mechanism of action through increased adrenal function? In this instance, instead of stimulating the gland by an andrenocorticotrophic hormone injection, it may be that we are stimulating it by forcing activity, injecting hope psychologically instead of by needle, and thrusting patients into an atmosphere of success and rehabilitation.

The relationship between "stress" situations and adrenal cortical function has been particularly emphasized by Selye[2] in his concept of the "general-adaptation-syndrome." He has shown, for example, that stress from exposure to cold will cause an enlargement of the adrenal cortex indicating greater activity. Others[3-5] have followed this cue and have tried to relate psychoneurotic fatigue symptoms to endocrine abnormalities as suggested by unusual response to "stress" situations. The level of circulating lymphocytes and eosinophils have been used to measure changes in adrenal cortical function in those studies. As we learn more about the complicated chain of events from the "alarm reaction" to the "stages of resistance and exhaustion" in the adaptation syndrome we may conceivably develop as a technic of physical medicine placing patients in or out of carefully controlled artificial "stress" situations. In any event it is a possible new line of investigation for us.

Mental disease research has continued to be baffling including attempts to evaluate Physical Medicine and Rehabilitation. In view of the great amount of time, money and effort spent in mental hospitals for treatment by this service, certainly every effort should be made to analyze critically the mechanisms which lead to apparent success as well as to seek out our reasons for failure. Some studies of adrenal function of the type mentioned above have been pursued and perhaps should be carried further in relation to our physical procedures.[5] Another way in which we can combine our forces in the research battle of disease is to apply careful measurements of physical performance in patients receiving endocrine therapy for this may, in addition to aiding evaluation of therapy, give us new leads as to the endocrine effects of procedures we are accustomed to employ and the physiology of exercise in particular. Certainly a big avenue for new types of research is now open to us in Physical Medicine and Rehabilitation.

2. Selye, H.: The Alarm Reaction and the Diseases of Adaptation, Ann. Int. Med. 29:403 (Sept.) 1948.
3. Watkins, A. L.; Cobb, S.; Finestinger, J. E.; Brazier, M. A. B.; Shands, H. C., and Pincus, G.: Psychiatric ad Physiologic Studies on Fatigue: Preliminary Report, Arch. Phys. Med. 28:199 (April) 1947.
4. Hoagland, H.; Elmadjian, F., and Pincus, G.: Stressful Psychomotor Performance and Adrenal Cortical Function as Indicated by the Lymphocyte Response, J. Clin. Endocrinol. 6:391 (April) 1946.
5. Elmadjian, F., and Pincus, G.: A Study of the Diurnal Variations in Circulating Lymphocytes in Normal and Psychotic Subjects, J. Clin. Endocrinol. 6:237 (April) 1948.

CHANGE OF ADDRESS

You are requested promptly to notify the office of the Archives of Physical Medicine, 30 North Michigan Avenue, Chicago 2, and your local postal authority of any change in your mailing address.

MEDICAL NEWS

Personals

By action of the Board of Governors, Dr. Frank H. Krusen was appointed as Treasurer of the American Congress of Physical Medicine, to serve out the unexpired term of the late Dr. John S. Coulter.

Dr. Stafford L. Osborne, professor of physical medicine at Northwestern University Medical School has been promoted to the Chairmanship of the department, effective January 15, 1950.

Dr. Louis B. Newman, Chief of the Physical Medicine and Rehabilitation Service, Veterans Administration Hospital, Hines, Illinois, was a principal guest speaker at a Rehabilitation Meeting sponsored by the Miriam Rose Bry Rehabilitation Hospital, St. Louis, Missouri, on January 16, 1950. Dr. Newman gave an illustrated lecture on Rehabilitation of the Disabled.

Dr. Michael M. Dacso has been appointed physician-in-charge of a reorganized department of physical medicine and rehabilitation at Goldwater Memorial Hospital, New York, a unit of the New York University-Bellevue Medical Center. The new department has been organized in conjunction with the department of hospitals, New York City, and Goldwater Memorial Hospital. Dr. Dacso will have direct charge of supervising research, teaching and medical care carried out in Goldwater's new rehabilitation wards, in which there are 100 beds. He will also supervise Goldwater Memorial Hospital's facilities for physical therapy, occupational therapy, recreation, prevocational guidance, speech therapy and psychologic testing. He is an assistant clinical professor on the college faculty.

New York Society of Physical Medicine

The regular monthly meeting of the Society was held Wednesday evening, January 4, in the New York Academy of Medicine Building. The scientific session consisted of a talk on "Rehabilitation —A World Wide View," presented by Drs. Henry H. Kessler and Hans J. Behrend.

Pennsylvania Academy of Physical Medicine

A meeting of the Academy was held in Philadelphia, Thursday evening, January 19, at the Surgical Clinic, University Hospital. The program consisted of the following papers: "Further Joint Temperature Studies in Arthritis," by Joseph L. Hollander, M.D.; "Infrared Heating of Tissue," by Francis X. Sweeney, M.D., and "The Effects of Microwave on the Pulse Volume, Digital Blood Flow and Temperature," by Emery K. Stoner, M.D.

Meeting Announcements

The annual convention of the American Occupational Therapy Association will be held in Glenwood Springs, Colorado, October 16th to 20th, 1950.

Medical authorities in the various fields will present new medical developments and their application to Occupational Therapy. Exhibits of Occupational Therapy materials and equipment will be displayed during the week.

The Convention will be held at the Colorado Hotel, internationally famous mountain resort.

American Association of Industrial Physicians and Surgeons—"Teamwork in Industrial Health," is the theme of 35th annual meeting to be held at Sherman Hotel, Chicago, April 22 to 29.

Exchange Fellowship Established by Mayo Clinic and New York University

The Physical Medicine Division of the Mayo Clinic and the Department of Physical Medicine and Rehabilitation of New York University College of Medicine, a unit of the New York University-Bellevue Medical Center, have announced jointly that the two institutions have established an exchange residency training program. Under the new plan, each institution's residents and fellows in physical medicine and rehabilitation will receive three months' training at the other institution.

In a joint statement announcing the plan, which started January 1, 1950, Dr. Frank H. Krusen, Director of Physical Medicine, Mayo Clinic and Dr. Howard A. Rusk, Chairman of the Medical Center's Department of Physical Medicine and Rehabilitation, stated, "The new exchange residencies will permit residents and fellows at each institution to have the benefits of the specialized training within physical medicine and rehabilitation which is available at both the Mayo Clinic and the New York University-Bellevue Medical Center. It is another step forward in the permanent union of physical medicine and rehabilitation as one medical specialty."

Exchange residents from the Mayo Clinic now at the Medical Center are Drs. George Twombly and Paul Nelson. Dr. Edith Kristeller is the Medical Center resident now at the Mayo Clinic.

Medical Days of Friendship

In the course of April, 1950, the International Society of Friends of Domus Medica, 111 East Oak Street, Chicago 11, Illinois, under the honorary presidency of Prof. Eugene Marquis, President of the World Medical Association, 1947-49, is organizing Medical Days of Friendship. During this month groups of American physicians making a trip, with the help of regular travel agencies, of two, three, or four weeks in Europe under the auspices of the Domus Medica, will be the guests for one day, the Medical Day of Friendship, of physicians of the most important countries visited.

Besides, the Domus Medica is organizing during this trip, receptions, meetings, and some manifestations of cultural, tourist, and scientific interest for these physicians and their families. Regarding this last point of view, every physician may let us know the particular fields in which he is interested, and he may be sure that we shall do the best we can to help him.

In Paris, the Medical Association of Paris will offer special medical receptions. In Rome, a special audience with the Pope for physicians and their families in honor of the Medical Days of Friendship will be asked.

As the International Society of Friends of Domus Medica is a not for profit organization, and since these trips will take place during the off-season, the prices of transportation, lodging, sightseeing, etc., will be reduced and places of interest will be less crowded.

A better knowledge and reciprocal esteem will be created; strong bonds of friendship will be established; and, thanks to the action of the Domus Medica, there will be new friends throughout the world; a modest, yet effective contribution to the establishment of World Peace.

The Domus Medica is at the disposal of all those interested in attaining the ideals of peace for which this organization is seeking, and of those wishing eventually to take part in these days, and desiring information and help.

National Foundation Grants

The National Foundation for Infantile Paralysis announces that 29 additional research and educational projects in infantile paralysis, totaling $849,738.68 in March of Dimes funds, have been awarded to scientific and technical institutions throughout the United States and Canada.[1] These additional studies bring the total expended by the National Foundation since 1938 to more than $11,000,000 each in the fields of research and education.

Among the recently approved research studies are grants of $28,000 to the Children's Hospital in Boston, for improving methods for "in vitro" propagation of poliomyelitis virus in non-nervous tissue; $49,300 to the University of California in San Francisco for further development of the flocculation method for virus identification and diagnosis of the disease; $17,200 to New York University—Bellevue Medical Center in New York, for development of a diagnostic complement fixation test; $28,990 to University of Toronto in Toronto, for experimental studies on prevention of the disease with high titer poliomyelitis antisera.

Also in research, are grants of $42,350 to Stanford University in San Francisco for studying the pathogenesis of poliomyelitis in the central nervous system; $26,000 to the University of Chicago in Chicago, for determining the origin of phosphorus and nitrogen in the virus; $25,480 to Western Reserve University in Cleveland for determination of the chemical differences between nerve cells that are resistant to the virus as compared with those that are susceptible; $10,605 to the Children's Hospital of Philadelphia to complete studies on the effects of nutrition on susceptibility and resistance to poliomyelitis; and $28,370 to the University of Wisconsin in Madison to determine the influence of nutrition on susceptibility and resistance to poliomyelitis.

Also included in research are grants of $5,235 to the Massachusetts General Hospital in Boston to determine the efficacy of tendon transplants as a treatment for crippling; $24,660 to Harvard University in Boston for a study of respiration and an evaluation of mechanical devices for artificial respiration; $6,200 to Columbia University in New York to determine the effect on the heart of various methods of artificial respiration; $15,540 to the United States Public Health Service in Bethesda to develop standards of muscle strength in relation to age, weight and sex as determined with a myodynamometer; $8,036 to Massachusetts General Hospital in Boston to complete a study of the value of progressive resistance exercises in the treatment of poliomyelitis.

Also included in the projects are awards of $15,365 to the University of Nebraska in Omaha for determining the sequential evolution of biochemical changes in atrophic and immobilized muscle; $5,150 to the University of Toronto in Toronto to complete studies on the physiological changes in denervated muscle; and $17,850 to Duke University in Durham for fundamental studies on the innervation and functional characteristics of human muscles.

Included in the newly announced awards are grants in education of $19,332 to New York University College of Medicine in New York to establish a reference center for information on assistive appliances and rehabilitation aids; $3,600 to the Boston University School of Nursing in Boston for the training of graduate nurses as clinical supervisors and teachers of orthopedic nursing; $5,500 to Catholic University of America in Washington, D. C., for short term courses in orthopedic nursing for graduate nurses; $11,400 to Georgia Warm Springs Foundation in Warm Springs for instruction to graduate physical therapists and occupational therapists in the treatment of infantile paralysis patients; $4,050 to Duke Hospital School of Physical Therapy in Durham to provide a clinical supervisor for physical therapy students at Lincoln Hospital; $11,400 to Vanderbilt University in Nashville for the preparation of

an illustrated manual on body mechanics and posture for the instruction of undergraduate and graduate students of nursing.

Also approved is an appropriation to provide fellowships of three to six months in principles of physical medicine and rehabilitation for physicians who are certified by or are preparing to meet the requirements of specialty boards in neurology, orthopedics, pediatrics and internal medicine. Further information concerning the fellowship programs can be obtained from the Educational Division of The National Foundation for Infantile Paralysis, Inc., 120 Broadway, New York 5.

Report of the Committee on Problems Affecting Physical Therapy and Occupational Therapy Technicians

No problems affecting physical therapy and occupational therapy technicians were called to the attention of the committee during 1948-49.

Since the American Physical Therapy Association is interested in legislation protecting the name "Physical Therapist," it was considered advisable to give some thought to the feasibility of such a move. Physical therapists have no legally defined independent status in most states. To date no one has attempted to delimit where the practice of physical medicine ends and the practice of physical therapy begins. Occupational therapists function more independently than physical therapists in the selection of activities designed to attain the objectives of treatment prescribed by the referring physician. The implications in the move being made by the American Physical Therapy Association are important to the physician and should be brought before the Congress. They were considered informally by the Committee on Problems Affecting Physical Therapy and Occupational Therapy Technicians but no action was taken in so far as the subject belongs more appropriately to the Committee on Legislation.

F. A. Hellebrandt, M.D., Chairman.
Frances Baker, M.D.
Robert W. Boyle, M.D.*
Madge C. L. McGuinness, M.D.
Arthur Pruce, M.D.

Report of Committee on Medical Economics American Congress of Physical Medicine

From the viewpoint of Medical Economics the practice of Physical Medicine is most inviting; the field of opportunity is practically unlimited. According to various surveys the number of people classified as "chronically ill" or having "long term disabilities" is ever increasing. The only real help for such people is through the specialty of Physical Medicine. Any community which is large enough to support a general hospital of 100 beds or more has in it enough cases requiring physical medical care to support a successful private practice.

The general qualifications are no different than for any other gainful endeavor; if a man has at least an average ability, is honest, and is willing to work, he can succeed. If he can deliver the goods the patients will beat a path to his door and demand his services.

In order for the Physiatrist to succeed in private practice he must be more than a consultant and a supervisor of technicians. First, the Physiatrist must be a diagnostician capable of making a complete differential diagnosis. This qualification is especially important inasmuch as the practice of Physical Medicine deals with all physical disability whether it be the result of disease or accident. The average patient, "Mr. Public," who supports private practice expects and demands such service. Second, the Physiatrist must have special skill which will be applied toward the patient's improvement or recovery. When the patient's recovery is the result of the work of the specialist there is no question about the security of the medical economics of the practice; the fee is justified by special service and the patient will compensate the physician not only with money, but also with acts of gratitude and patient references. Patient reference becomes the dependable source of supply in private practice and when such a chain is once built no competitor can break it. When considering private practice it is futile to engage in lengthy discussions about space, organization, equipment, etc. After the beginning is made, the growth of the practice will determine the whole plan and its requirement.

The field of Physical Medicine is unchallenged; there is no competition. No greater, wide open opportunity exists in our profession.

Milton G. Schmitt, M. D., Chairman.
Emil J. C. Hildenbrand, M.D.
Ray Piaskoski, M.D.
Herman L. Rudolph, M.D.
Walter M. Solomon, M.D.
Bror S. Troedsson, M.D.
George D. Wilson, M.D.

Report of the Committee on Public Relations

The Committee is happy to report that the public relations of the Congress continue to be favorable. The relationships of the Congress with other medical groups and with the governmental services have remained cordial. Our relationships with physicians from foreign countries have been fostered and an increasing number of physicians from other countries have attended and participated in our meetings.

In the hope of promoting still further our relationships with specialists in physical medicine in other parts of the world, the Committee recommends favorably the plan to have the Congress participate in an International Congress on Physical Medicine which it is proposed shall be held in London in 1951.

Frank H. Krusen, M.D., Chairman.
Robert L. Bennett, M.D.
William H. Schmidt, M.D.

BOOK REVIEWS

ISOTOPIC TRACERS AND NUCLEAR RADIATIONS WITH APPLICATIONS TO BIOLOGY AND MEDICINE. By *William E. Siri*. With contributions by Ellsworth C. Dougherty, Cornelius A. Tobias, Rayburn W. Dunn, James S. Robertson and Patricia P. Weymouth, Division of Medical Physics, Department of Physics and Radiation Laboratory, University of California. First Edition. Cloth. Price, $12.50. Pp. 653 with 136 illustrations. McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 18, N. Y., 1949.

A brief review can hardly do justice to this important, up-to-date, and comprehensive volume. Part I deals with Isotopes and Nuclear Radiation; it summarizes the knowledge of elementary particles and gamma rays, and ends with a 72-page version of the Seaborg-Perlman table of isotopes into which are condensed the results of an incredible amount of human endeavor. Part II deals with Methods and Instruments; it describes instruments for determining both radioactive and stable isotopes, discusses thoroughly the various counting devices such as the Geiger-Müller apparatus, summarizes the theory of tracer methods, the safe handling of radioactive materials, and the operation of generators and accelerators, including the synchrotron. The text here is well illustrated. Part III deals with Biological and Medical Applications of Isotopes, and includes particularly a 10-page chapter on therapy and diagnosis. The authors are to be commended for using the word "micronutrient" in place of the phrase "trace element," since the latter is so easily confused with "tracer element." The book ends with a 91-page bibliography and an index. This last, under "Isotopes" promises a definition on page 1, which the reviewer was unable to find. It must be admitted that this volume is not for beginners.

NERVOUS AND NEUROHUMERAL REGULATIONS OF INTESTINAL MOTILITY. Monographs in the Physiological Sciences. By *W. B. Youmans*, Professor of Physiology, University of Oregon Medical School. Cloth. Price, $4.75. Pp. 179, with 32 illustrations. Interscience Publishers, Inc., 215 Fourth Ave., New York 3, N. Y., 1949.

This excellent monograph is a summary of the present status of knowledge concerning the role of extrinsic nerves of the small intestine in the regulation of intestinal motility. The author has had a continued interest in this difficult field of research since 1936.

The material has been carefully planned and admirably presented. Each chapter closes with an excellent summary and a well chosen group of references. The original research of the author makes a very valuable contribution. Inasmuch as there is considerable confusion in terminology as applied to physiology and pharmacology, the writer, in his introduction clarifies the terminology as used in his text. This is no mean task. He also presents an interesting section in the introduction on the physiologic types of smooth muscle. The physiologist will find this of great value. Since physical medicine is now devoting a great deal of attention to research this volume will serve as a useful reference work for the physiatrist engaged in investigative work. The volume is well illustrated. The text is written in concise and excellent style. The facts are presented in logical sequence. The author merits a great deal of praise for his painstaking work. The book is recommended to physiatrists and physical therapists as an excellent reference work for their library.

ULTRASONICS. By *Benson Carlin*, Hillyer Instrument Company, Incorporated, formerly with Sperry Products. Cloth. Price, $5.00. Pp. 270 with 159 illustrations. McGraw-Hill Book Company, Incorporated, 330 West 42nd Street, New York 18, N. Y., 1949.

Biological work in the use of supersonic waves has developed over the last twenty-five years. It is only recently that clinical applications of ultrasonic waves have been described, particularly in the European literature. Much confusion exists among clinicians and physiologists about the technic of ultrasonic waves. The present book is an excellent guide for those who want to familiarize themselves with this new field. While the book is undoubtedly technical, not too much mathematics has been included, and the very clear style makes it a pleasure to read.

The first two chapters deal with the theory of high frequency sound waves. They are a very lucid description of such phenomena as reflection and refraction, loss of energy and the measurement of this energy. The reasons why the application of ultrasonics to biological specimens is so much more difficult than the application of the usual physical medicine technics should become obvious from these chapters.

Much of the work in ultrasonics is concerned with the development of the sound reproducer. It is a very simple matter to produce electrical energy to energize this reproducer, however the actual reproducer itself offers a number of problems. The author describes both crystal reproducers and magnetostriction reproducers. The remaining chapters of the book are devoted to some of the practical difficulties encountered in studying the effect of these high frequency sound waves.

Of particular future technical interest are the articles on pulsed ultrasonic systems. It could be expected that these systems will have considerable value in biological applications.

Some of the technical procedures in which ultrasonics are being used at present are described in the last chapter of the book, and while medicine rates only one small final paragraph saying mainly that nothing of importance has been done so far, much can be deducted from applications in other technical fields which will eventually be very useful in medical applications.

This book should be read by everyone who attempts to familiarize himself with this new field of medical physics which will undoubtedly very rapidly find its clinical application in physical medicine.

MEDICINE. Volume II. By *A. E. Clark-Kennedy*, M.D., F.R.C.P. Fellow of Corpus Christi College, Cambridge; Physician to the London Hospital and Dean of the Medical School. Cloth. Price, $7.00. Pp. 509. The Williams and Wilkins Company, Mount Royal and Guilford Aves., Baltimore 2, 1949.

The first volume of this work was reviewed in the April, 1949 issue of the ARCHIVES OF PHYSICAL MEDICINE and was favorably received. In the first volume the titles of the chapters were diagnosis, prevention and treatment whereas in this second volume they are clinical diagnosis, special investigations, disturbance of function, reaction of the mind, pathologic processes, and the practice of medicine.

Chapter VIII on Special Investigations brings out the style of the author. In this chapter most of the examinations are briefly considered such as roentgen studies of the various parts of the body, bronchoscopy, microscopic structure of tissue, compliment fixation tests, skin reactions, metabolism, electrocardiography and numerous others. These are all covered in 92 pages which obviously cannot be complete but is more of an effort to evaluate the special investigations as an aid to diagnosis in an overall picture. Frequently the tests are deprecated "merely as cover, something to shelter behind in case of criticism." It is certain that this chapter is not intended as a reference for the indications and explanations for special laboratory, roentgen or other examinations but to bring these tests into the proper perspective. According to the author they should be an aid and not the end to the diagnosis. The other five chapters are presented with a similar purpose.

Dogmatic statements are made and colorful phrases and sentences are included which tend to maintain a sense of suspense and excitement which may or may not have been the intention of the author. The following are examples: "every throat should be swabbed"; "transient paralysis is unimportant"; "nevertheless, granted the ways and means, if a patient is entitled to an anesthetic to spare him the pain of an operation and to continuous narcosis when suffering from tetanus, meningitis or an acute anxiety state, there is no reason, if the moral law permits, why he should not be allowed continuous narcosis to spare him pain at death"; "the stony hard glands felt through the skin must be carcinoma"; "more often the appeal to reason (in the chapter on reactions of the mind) is founded on unselfishness, which the patient ought to possess, rather than his own interest, which he ought to discount"; "the degenerative changes in the ageing man cannot be thrown into reverse"; "polygamy is only found when wealth has accumulated in the hands of few"; the doctor in his training had "the impression in his mind at that age that the practice of medicine was essentially scientific. Now he may be disappointed as he finds that much of it is far less exact than he had expected. Empirical judgment counts for much; precise knowledge sometimes for little." These numerous quotations are mentioned in this review, and there are hundreds of others just as worthy of quoting, in order to show the type of writing in the book. It is unorthodox and thought provoking.

The author as a teacher in the London Medical School must influence his students to think of patients and their disorders from a different approach from that of automatic and uncorrelated memorizing of facts. This definitely has merit. Many statements are debatable and at times antagonistic but the reading of the book leaves an excellent impression.

These two books will never have a tremendous popular appeal but should be appreciated by those who enjoy writing which is done in a most fascinating style and which is intended to appeal to the intellect.

THE COMMON FORMS OF JOINT DYSFUNCTION: ITS INCIDENCE AND TREATMENT. By *William Kaufman*, Ph.D., M.D. Fabrikoid. Pp. 208, with illustrations. Price, $8.75. E. L. Hildreth & Co., Brattleboro, Vt., 1949.

This monograph is the report of a two year study of 455 patients in the author's private practice. He proposes the theory that the pathologic process in rheumatoid arthritis and degenerative joint disease is due in a large part to a deficiency of niacinamide and how the reparative process can be brought about in most cases by large and prolonged use of niacinamide. Not all will agree with his hypothesis or be impressed with his case reports. The diagnosis might even be questioned in several. It is difficult to be sure just what disorder is being treated in the numerous cases labeled "joint dysfunction (without obvious arthritis)." Emphasis is placed on four complicating syndromes — (1) delayed post-traumatic articular, (2) chronic allergic, (3) sodium retention, and (4) psychogenically induced, sustained hypertonia of somatic muscle. These syndromes must be corrected if niacinamide therapy is to change the joint range index or if these associated symptoms are to improve. The discussion of these syndromes is either too obvious or not pertinent to the problem of joint dysfunction. The rationale for the use of

niacinamide is not given. Of course this is not always possible but it should have some justification. This may have been considered in the author's earlier publication to which a reference is made but for those who have not read this work and this may include quite a number, a few paragraphs should have been added.

A feature of the book that is commendable is the measurement of joint motion. The gravity type of goniometer is used which is not the simplest nor the most accurate. The collar for neck motion, the wrist plate and the device for measurement of the metacarpal phalangeal joints are ingenious and could be employed more extensively. He employs a "joint range index" which is defined as the "arbitrarily weighted mean of the numerical value obtained upon the measurement of the 20 specified joint ranges" and is used to note the changes in joint dysfunction. This has merit.

CLINICAL INTERPRETATION OF LABORATORY TESTS. By *Raymond H. Goodale*, M.D., Pathologist of the Worcester City Hospital, Worcester Hahnemann Hospital, Belmont Hospital, and Fairlawn Hospital, Worcester, Mass.; Clinton Hospital, Clinton, Mass.; Harrington Memorial Hospital, Southbridge, Mass. Consulting Pathologist, Veterans Administration Hospital, Rutland Heights, Mass. First Edition. Cloth. Price, $6.50. Pp. 605 with 107 illustrations. F. A. Davis Company, 1914-16 Cherry Street, Philadelphia 3, Pa., 1949.

The book is divided into two parts. The first part considers the usual laboratory tests and examinations of the various body fluids and excreta. The second part deals with diseases and disorders of the different systems and organs of the body and their associated laboratory findings. Very brief clinical facts precede each disease that is considered. This is not the most comprehensive book on this subject which should make it a serviceable book for students and busy practitioners. They will find the material conveniently and accurately presented and sufficiently complete to satisfy their needs.

HEALTH INSTRUCTION YEARBOOK, 1949. Compiled by *Oliver E. Byrd*, Ed.D., M.D., F.A.P.H.A., Professor of Health Education, and Director, Department of Hygiene, School of Education, Stanford University. Cloth. Price, $3.50. Pp. 276. Stanford University Press, Stanford, California, 1949.

Like its eight annual predecessors, the 1949 Health Instruction Yearbook is a compendium of broad health information. In this edition 225 articles were chosen for condensation from 1,643 articles appearing during the past year. Primarily because of the space devoted to arguments for and against socialized medicine, the greatest number of selections came from the Congressional Record. This periodical provided 37 abstracts for the Yearbook, whereas the Journal of the American Medical Association supplied 30 condensations. There are 21 chapter titles, among them Exercise and Body Mechanics, Fatigue and Rest, Infection and Immunity, Habit-Forming Substances, Health and the Physical Environment, Family Health, School Health, Occupational Health, Community Health Services, International Health, and Trends and Possibilities. A synopsis and comments head each chapter, enabling a rapid survey of its contents. Clear typography, ample subheads and a bibliography, alphabetical list of sources, plus author and subject index makes this one of the most easily readable and informative yearbooks.

APPLIED BIOPHYSICS. SURVEY OF PHYSICAL METHODS USED IN MEDICINE. A Symposium. Edited by *N. Howard-Jones*, M.D., Editor, British Medical Bulletin. Cloth. Price, $6.75. Pp. 293. Chemical Publishing Co., Inc., 26 Court St., Brooklyn 2, N. Y., 1949.

The specialist in Physical Medicine should be conversant with the applications of biophysics beyond the therapeutic confines of his field of practice. This book accordingly is useful for the physiatrist in training, as well as a brief reference for general practitioners interested in broadening their basic knowledge. A wide variety of physical phenomena are explained by 17 contributors. Some of the subjects discussed include: applications of electronics and heat; mechanical injuries, and in particular the physical basis for the biological effects of penetrating radiations such as x-rays, neutrons and other ionizing radiations including their genetic effects and action on tumors. This text might be used to advantage as a basis for study to fulfill in part the basic science requirements for residents in Physical Medicine.

APPLIED ANATOMY AND KINESIOLOGY. THE MECHANISM OF MUSCULAR MOVEMENT. By *Wilbur Pardon Bowen*, M.D., Late Professor of Physical Education, Michigan State Normal College, Ypsilanti, Michigan. Sixth edition, revised by *Henry A. Stone*, M.S., Associate Supervisor, Department of Physical Education, University of California, Berkeley, California. Cloth. Price, $4.75. Pp. 390, with 234 illustrations, 18 in color. Lea & Febiger, 600 S. Washington Square, Philadelphia 6, 1949.

This book is designed as a basic text for physical education students. Static and functional anatomy is well presented verbally and with drawings and diagrams. Study questions and review outlines are included. In the final section, posture, walking, running, games and sports are analyzed from the point of view of kinesiology. This is recommended as an excellent text for physical education and physical therapy students, although for the latter inclusion of therapeutic exercises would be desirable.

POSTTRAUMATIC EPILEPSY. By *A. Earl Walker*, M.D., Professor of Neurological Surgery, The Johns Hopkins University, Baltimore, Md. Publication No. 20, American Lecture Series. A Monograph in American Lectures in Surgery. Cloth. Price, $2.75. Pp. 86, with 20 illustrations. Charles C Thomas, Publisher, 301-327 E. Lawrence Ave., Springfield, Ill.; Blackwell Scientific Publications, Ltd., Oxford, England; The Ryerson Press, 229 Queen St., W., Toronto 2B, Canada. 1949.

This monograph is one of the Series of American Lectures in Surgery and presents the clinical aspects of clinical surgery in some detail because the general practitioner is especially concerned with this phase of the subject.

Posttraumatic epilepsy is a common complication of penetrating wounds of the head. The treatment of this condition has improved during the past ten years by the introduction of more effective and less toxic anticonvulsant drugs. At the same time a better understanding of the neural mechanisms involved in focal epilepsy has led to surgical procedures which offer a great deal to the patient who is not relieved by conservative medical therapy.

Based on a large number of cases — with which the author has had contact and also cases which have been reported by other researchers — this monograph represents a comprehensive picture of the status of posttraumatic epilepsy today. Diagnosis and treatment, both medical and surgical, are evaluated on the basis of the results in hundreds of cases.

Twenty illustrations, an ample bibliography and a good index add to the usefulness of the book. The typography is of the usual quality and artistry of the publisher.

STOMACH DISEASE AS DIAGNOSED BY GASTROSCOPY. By *Eddy D. Palmer*, A.B., M.S., M.D. Major, Medical Corps, United States Army. Formerly Chief, Gastrointestinal Section, Walter Reed General Hospital, Washington, D. C. Foreword by *R. W. Bliss*, M.D., Major General, Medical Corps, The Surgeon General, United States Army. Cloth. Pp. 200 with 53 illustrations and 56 plates in color. Price, $8.50. Lea and Febiger, Washington Square, Philadelphia 6, Pa., 1949.

Gastroscopy is now considered an important adjunct in the diagnosis of stomach disorders. That it has limitations is admitted. Throughout this book the author stresses the variations that might lead to error in the gastroscopic interpretation which is a most helpful and essential feature of the work.

All the various lesions of the stomach are considered including ulcers, acute and chronic gastritides, benign and malignant tumors, both intrinsic and extrinsic, and the gastroscopic changes following stomach operative procedures and in diseases associated with gastric symptoms such as the duodenum, liver and biliary tract and certain metabolic and skin diseases. Short case reports are included in which the gastroscopic findings are correlated with the clinical, roentgenological and laboratory information.

The author presents the material clearly and briefly combining the knowledge secured from his own extensive experience and from the ever increasing amount of information available from the literature. The illustrations, particularly those in color, are well chosen and reproduced. The book should be a valuable addition to the libraries of gastroscopists, gastroenterologists, internists and gastric surgeons.

THE RETURN OF ADAM SMITH. By *George S. Montgomery, Jr.*, LL.D. Cloth. Price, $2.50. Pp. 147. The Caxton Printers, Ltd., Caldwell, Idaho, 1949.

The arguments for a strong, free America and the dangers and fallacies of communism are strongly, clearly and concisely presented. The argument is based on the "Wealth of Nations" by Adam Smith and takes issue with modern educational trends on matters of economics. Although not written specifically for physicians, it should help them to think more clearly at this critical time with its trend to nationalization and loss of freedom. The short time required for reading should increase rather than lessen the value of this book.

EPILEPSY AND CONVULSIVE DISORDERS IN CHILDREN. By *Edward M. Bridge*, M.D. Research Professor of Pediatrics, School of Medicine, University of Buffalo; Director of Research, Children's Hospital of Buffalo; Formerly Associate in Pediatrics, Johns Hopkins School of Medicine, and Physician in Charge, Johns Hopkins Epilepsy Clinic. Cloth. Pp. 670. Price, $8.50. McGraw-Hill Book Company, 330 West 42nd St., New York 18, 1949.

This book is a thorough going presentation of all the known facts concerning seizures, convulsions and epilepsy. Dr. Bridge has had an unusual wealth of source material on which to base his book, the major part of which comes from experiences accumulated in the Epilepsy Clinic at Johns Hopkins over a period of sixteen years.

In addition to the clinical problems of causation and diagnosis, this study examines closely the psychiatric and sociological aspects of the disease. The work and observations of the Epilepsy Clinic confirm the importance of this psychosomatic concept of epilepsy. Details of practical management of afflicted children which are so often overlooked in medical writings are included throughout the chapters of the book and in several sections of an extensive appendix. An unusual feature of this book is a pictorial table of contents placed at the beginning of each chapter. The purpose of such a presentation is the hope that through the medium of pictures the material will be more easily assimilated by the medical profession and that others with less background in science will also be enabled to appreciate the problems of epilepsy.

HANDBOOK OF ELECTROENCEPHALOGRAPHY. By *Robert S. Ogilvie*. Cloth. Pp. 137. Price, $5.00. Addison-Wesley Press, Inc., Kendall Square Building, Cambridge 42, Mass., 1949.

This handbook is primarily a guide for those who are embarked on the career of electroencephalographic technician. However, it may be useful to the physician and medical student desiring a brief, didactic introduction to this increasingly important specialty.

PSYCHOLOGY OF PERSONAL ADJUSTMENT: STUDENTS' INTRODUCTION TO MENTAL HYGIENE. By *Fred McKinney*, Professor of Psychology and Psychologist in the Student Health Service, University of Missouri, Columbia, Mo. Second edition. Cloth. Price, $6.00. Pp. 752, with illustrations. John Wiley & Sons, Inc., 440 4th Ave., New York 16; Chapman & Hall, Ltd., 37-39 Essex St., Strand, London, W.C.2, 1949.

This is the second edition of a popular book on psychology for young men and women. It should appeal particularly to this age group attending college. It includes material usually taught in courses on mental hygiene. The titles of some of the chapters are as follows: adjustment to college work; concentration, learning and thinking; personal efficiency; development of personality; social adjustment; self confidence, etc.

This volume could be a supplementary text for a course in general psychology. It is written for easy and rapid reading, makes use of numerous case reports and each chapter is followed by many references for additional reading on that particular subject. The book should interest many students who find it difficult to work efficiently at their studies or to make an adequate social adjustment.

SUPPLEMENT TO CHILD HEALTH SERVICES AND PEDIATRIC EDUCATION. Methodology and Tabulations on Services. Report of the Committee for the Study of Child Health Services. The American Academy of Pediatrics with the Cooperation of the United States Public Health Service and the United States Children's Bureau. Price, $3.50. The Commonwealth Fund, 41 East 57th St., New York 22, 1949.

This volume is a supplement to the survey made and published by the joint agencies of The American Academy of Pediatrics, U. S. Children's Bureau, and the U. S. Public Health Service. That report made available information on existing facilities and services for the health of children throughout the United States and on graduate and undergraduate pediatric education. This supplement deals with a description of the methods used in gathering material for the former and more condensed report. Thus with the publication of the two reports all of the basic data collected in the study relative to child health services and pediatric education are fully presented.

The tables used in gathering the data are presented and should serve as an excellent guide for other related studies. This supplement volume deals entirely with the methods used in gathering and analyzing the material and, hence, is composed largely of tables of data and its significance.

CHILD HEALTH SERVICES AND PEDIATRIC EDUCATION. Report of the Committee for the Study of Child Health Services. The American Academy of Pediatrics with the Cooperation of the United States Public Health Service and the United States Children's Bureau. Pp. 270. Well illustrated with graphs and tables. Price, $3.50. The Commonwealth Fund, 41 East 57th St., New York 22, 1949.

This study began as a result of a meeting in the fall of 1944 of a group of pediatricians who decided that if there was to be real advancement in child care it must be made with existing agencies. As a result a nation-wide study was instituted by the American Academy of Pediatrics with the assistance of the U. S. Public Health Service and the U. S. Children's Bureau. The task of the committee was to find facts and to report them and not to formulate recommendations although there was a great temptation to draw forth answers not only to the question "what is" but also to the question "what ought to be."

Part I of the report attempts to bring out the highlights of the factual information related to private practice, hospital facilities and the services of community health agencies.

Part II deals with an evaluation of pediatric education. The information was obtained by personal visits to all of the medical schools, and all of the hospitals approved for pediatric residency. This is a most valuable contribution.

Part III is given to a general summary of the study.

Anyone interested in child health from the general practioner to the specialist in pediatrics, nurses and social workers this volume should prove of the greatest value and interest. It is an excellent example of how federal agencies and private practice can successfully work together to accomplish results impossible were each working alone. This volume is highly recommended to physiatrists and physical therapists.

THE INTRAMURAL HANDBOOK. By *Carl D. Voltmer*, Ph.D., Professor of Health and Physical Education, College of the Pacific, Stockton, California; and *Vernon W. Lapp*, Ph.D., Associate Professor of Physical Education, University of Nebraska, Lincoln, Nebraska. Paper. Pp. 176, illustrated. Price, $3.00. The C. V. Mosby Company, 3207 Washington Blvd., St. Louis 3, Mo., 1949.

The purpose of this book is to provide the active intramural director with a handy reference when he is making schedules and planning new intramural events, and to provide the professional student in physical education with a basic work book in this field.

PHYSICAL MEDICINE ABSTRACTS

Fibrositis. George D. Wilson.

South. M. J. **42**:387 (May) 1949.

Classification of fibrositis into two common types was found most convenient in this series. Primary fibrositis is that type unaccompanied by and independent of other disease. Secondary fibrositis was designated as that type secondary to hypertrophic arthritis, alcoholism, diabetes, tuberculosis, menopausal syndrome, faulty metabolism, hypothyroidism and repeated trauma. The use of goniometry is most important in that it measures in degrees the limitation of joint motion. Likewise, goniometry reveals the patient's clinical improvement under treatment. It was found helpful in the thoracolumbar and dorsodynia cases to use the tape line to measure trunk flexion, finger tip to floor and to measure respiratory excursions. Physical therapy offers a superior form of treatment for fibrositis. Fibrositis is best managed in office practice on a biweekly or triweekly basis and at the same time the patient should continue his daily routine of activity. The physician wisely advises the patient that this condition may recur or become chronic. Treatment requires considerable patience and perseverance on the part of both patient and physician. The local application of deep heat with short wave diathermy is most beneficial. The most efficient method was found to sandwich the involved area between pad applicators. The use of microthermy was found just as efficient and it is best to inform the patient there may be an aching or drawing sensation while under the diathermy. Following the use of diathermy massage is employed, at first light massage to the involved areas, and gradually much firmer pressure should be used, and petrissage as the patient's improvement permits. Active exercises are mentioned here in fibrositis only because it was found advisable for patients to carry the extremities through their normal range of joint motion as far as the pain and tense muscles will permit. Forced stretching of tense fibrositis involved muscles by manipulation or pulleys without first obtaining relaxation through the use of heat leads to aggravation or early recurrence of an inflammatory process. Active exercises are advised as tense, painful muscles will permit an increased range of motion. As the pendulum swings surely from overrest to overactivity in medicine, it is timely that exercises be prescribed as the condition of the patient warrants. The use of neostigmine 1 cc. of 1:2,000 solution subcutaneously, given consecutively for 7 to 10 days, did not materially shorten the course of the disease but appeared to speed the time of relief from the complaint of tenseness, permitting earlier freedom of motion. It is an adjunct to the physical therapy.

On Teaching Physics to Medical Students. D. W. Smithers.

Brit. M. J. **4626**:512 (Sept. 3) 1949.

The reason for inviting a radiotherapist to write about the teaching of physics is presumably that radiotherapists are so clearly concerned with the application of physics in medicine, and that they have been foremost in recognizing the need for the appointment of hospital physicists. Radiotherapists are not, however, alone in their interest in medical physics, the place of which is hardly given adequate recognition by astonishing statements such as the following which appeared in a leading article in the British Medical Journal in 1945: "At present the application of physics to medicine is limited to radiology, the electrocardiograph, and the encephalograph in diagnosis, and the somewhat empirical use of various forms of radiant energy in treatment; but it is highly unlikely that these represent more than a fraction of the contribution physics might make to human biology."

Physical methods of diagnosis and treatment have become indispensable in medicine and have so expanded in recent years and have covered so many branches that it was possible to publish in the United States a year before the above quotation was written an encyclopaedia of medical physics of 1,744 pages under 255 main headings listed in the table of contents (Glasser, 1944). The extension of the employment of physicists in general hospitals only awaits an initiative in other clinicians similar to that shown by radiotherapists; in fact, the latter have already established physics departments in most large hospitals which are ready and are waiting to be called on.

Dynamic Therapeutics in Chronic Disease. Howard A. Rusk.

Virginia M. Monthly **76**:271 (June) 1949.

Today, as medical science moves foward in the prevention and cure of infectious disease, chronic illness has become the nation's primary medical problem. One of the principal causes of the increasing prevalence of chronic disease has been the great advances in medical and surgical care which have prevented death and produced an aging population. Two thousand years ago, the average length of life was 25 years; at the turn of the century, it was 49; today, it is 66. In 1900, 1 person in 25 was 65 years of age or older; it is estimated that in 1980, the ratio will be 1 in 10. The chances are now two out of three that a young man now starting his working life at the age of 18 will live to his retirement age of 65. As people become older, their medical needs change, and they demand more medical service. In 1940, the 26.5 per cent of the nation's population over

45 required over half the nation's medical services. By 1960, it is expected that the number of persons over 45 will constitute nearly half of the population. With the introduction of rehabilitation programs in general hospitals, increased facilities for convalescent care and home care programs of medical, social, visiting nurse and visiting housekeeper services, many of the aged and chronically ill will not need to seek admittance to public homes. Many present residents could be restored either to employment or self-care with the introduction of dynamic rehabilitation programs. If the aged and chronically ill are to have the comfort, security, dignity and companionship that should be the heritage of every older person, public homes must provide them with cheerful, attractive surroundings, as much privacy as possible, a place for their belongings, opportunities for recreation and social activity and a chance to do something productive. With the growing incidence of disability due to chronic disease, medicine must assume a great deal of the leadership in the responsibility of society which Dr. Edward L. Bortz so aptly summarized when he said, "The society which fosters research to save human life cannot escape the responsibility for the life thus extended. It is for science not only to add years to life, but, more important, to add life to the years."

Carditis in Poliomyelitis: An Anatomic Study of Thirty-five Cases and Review of the Literature. Theodore E. Ludden, and Jesse E. Edwards.

Am. J. Path. **25**:357 (May) 1949.

This investigation was undertaken because of the relative paucity of reports in the literature regarding cardiac lesions in cases of acute poliomyelitis and because certain unusual cardiovascular lesions were observed during the 1946 epidemic in Minnesota. Myocarditis occurs frequently in acute poliomyelitis, having been observed in 14 (40.0 per cent) of 35 cases of fatal poliomyelitis. Acute vegetative endocarditis and endarteritis of a patent ductur arteriosus may occasionally be found in acute poliomyelitis. One example of each of these lesions was present among the cases in this study. Since the cardiovascular lesions occurring in the cases included in this study were otherwise unsatisfactorily explained, poliomyelitis virus must be considered as a possible cause of such lesions. Proof that cardiovascular lesions in acute poliomyelitis are caused by the poliomyelitis virus will depend on demonstration of the virus in the lesions and the experimental production of such lesions. The diagnosis of myocarditis in acute poliomyelitis is seldom made during life. Myocarditis should be suspected in every patient who is seriously ill with acute poliomyelitis. Myocarditis, as observed in this series of cases, was usually more severe and proportionately more common in adults than in young children. The ratio of males to females in the group of patients with myocarditis was 2.5:1, but since the ratio of males to females in the study was more than 3:1, actually a slightly greater proportion of females had myocarditis. There was no specific correlation of type of paralysis—bulbar or spinal—with the presence or absence of myocarditis. The actual role of myocarditis as a cause of sudden death in acute poliomyelitis could not be determined in this study, except in one patient, who had a perforation of the right atrium. Three of the 6 patients who died suddenly were found to have myocarditis, but all of these patients had bulbar involvement, which might have explained their sudden deaths.

Iontophoresis in the Treatment of Peripheral Vascular Disease. H. S. Pemberton, and D. C. Watson.

Brit. M. J. **4628**:633 (Sept. 17) 1949.

Among the methods of treatment designed to overcome vasospasm or to produce vasodilatation in peripheral vascular disease is the use of choline derivatives.

The present series, comprising 83 unselected cases, covers the period from 1938 to 1948. The cases are divided into three almost equal groups by the exigencies of the recent war. Having used mecholyl from 1938, the authors were deprived of it in 1941 and used doryl, moryl, and carbachol as substitutes. It was not until 1946 that acetyl-B-methylcholine again became available as amechol.

The standard adjuvant treatment given to these patients consisted of rest, warmth and antiseptic measures where necessary; in cases of diabetes mellitus the blood-sugar level was kept within reasonable limits. The patients were usually in bed, though the majority of cases of intermittent claudication were treated as outpatients. The greater value of acteyl-B-methylcholine for this purpose is shown.

Hypertensive Heart Disease. A. L. Cooper.

Kentucky M. J. **47**:305 (Aug.) 1949.

The treatment of hypertension is a source of much discouragement. The removal or correction of primary factors should have first consideration. The management should be divided into at least six categories; psychotherapy, rest, physical therapy and x-ray, diet, medicines, and surgery. There are a number of things which the physician does well to remember in treating a person with high blood pressure. An effort should be made to readjust his life, so that unnecessary strain on the heart and blood vessels does not occur. Irritability, anxiety, fear, resentment and an alternate aggression and dependence are typical emotional attitudes of the hypertensive patients. They are sensitive to petty annoyances and especially personal slights, disagreements or altercations. Self recrimination for those traits is always indulged in by these patients who may revolve in a sort of emotional vicious cycle, especially when they have been told that emotionality aggravates the blood pressure. For the physician not trained in psychiatry the best treatment for these disturbances seems to be the use of reassurance, sympathy, and encouragement. At least nine hours in bed, when possible, is needed and the patient should be advised to try to cultivate a habit

of resting one hour every morning and two hours in the afternoon. Physical therapy at the present time has a very limited place in the treatment of hypertension.

The Heat of Activation and the Heat of Shortening in a Muscle Twitch. A. V. Hill.

Proc. Roy Soc. Med., Series B **136**:195 (June 23) 1949.

From previous work (e. g., Hill 1939) on the heat produced in a tetanic contraction, it was necessary to assume that heat was produced, quite independently of shortening or work, in the process by which a contraction is maintained. It may not be concluded that the "maintenance heat" in a tetanus is nothing more than the summated effect of the "activation heat" produced in response to each of the series of shocks composing the tetanus. It will be shown in a later paper that the activation heat begins very soon after a stimulus, its maximum rate being at the start like the discharge of a condenser through a resistance. Of the nature of the physical or chemical processes underlying it we have at present no evidence, but it represents presumably a "triggered" reaction setting the muscle in a state in which it can shorten and do work. If it shortens, extra heat is given out in proportion to the amount of shortening; if it does work, extra energy is mobilized to provide the work, but, for a given amount of shortening, the heat is unaffected. Whether the heat of activation, the heat of shortening and the work are derived from different physical or chemical sources we cannot yet say; but they can be so sharply distinguished from one another that there is no logical necessity to assume them to be derived from a single one.

Intra-articular Temperature as a Measure of Joint Reaction. Steven M. Horvath, and Joseph L. Hollander.

J. Clin. Investigation **28**:469 (May) 1949.

Clinicians studying rheumatic diseases have long used the surface temperature over the joints as indicative of the degree of synovial reaction. Many of the terms used in rheumatology imply temperature changes in the joint tissues, viz., "the acute hot joint of gout," "the cold swelling of chronic rheumatoid arthritis," the so-called "friction effect" or "heating-up" of osteoarthritic joints following exercise, or "articular jelling" (implying excessive joint cooling and stiffening on prolonged rest). Many measurements have been made of the skin temperature over diseased joints, but no study on intra-articular temperatures in human joints has been reported. Several studies have been made of intra-articular temperature in dogs and one study was performed on the stifle joint of a horse to determine the coefficient of friction within the joint, with and without synovial fluid. A method for determination of the temperature of the articular cavity has been developed which appears to have a practical use both to measure the degree of inflammation in the joint and to determine the effect of external influences on joints. Intra-articular temperatures correlated somewhat more closely than the surface temperatures over the joint with the clinical activity of rheumatoid arthritis. The joint temperatures in degenerative joint disease were higher than anticipated from relative clinical activity. This might be related to greater joint friction effects and to retarded cooling. The joint temperature fell when hot packs were applied over the joint, and rose with the application of cold packs. The magnitude of these responses was affected by seasonal influences being greater in the winter than in the summer.

New Concepts in the Management of Cerebral Palsy. Weston Cook.

J. South Carolina M. A. **45**:248 (Aug.) 1949.

A special exercise and training program is the crux of what might be termed the new concept of the treatment of cerebral palsy. The basic idea underlying this training program is that in the presence of a normal mentality, even though the child may be unable to learn basic activities automatically because of the physical handicaps present, still it is possible to teach this child by a repetitive exercise program. Thus, he learns the activity in much the same manner that a normal child learns higher skills, such as swimming. So, after necessary surgery and bracing are provided, the child is considered from the standpoint of what goals are to be sought. Can he be taught to walk? Or is the handicap too great, and would it be wiser to accept a wheel-chair life and work for arm function for this activity? Once the goal is determined, a program of exercises is set up with the assistance of trained technical specialists—physical and occupational therapists. With this program weakened muscles are strengthened, involuntary motions are diminished by relaxation and gradually, motion patterns become habits. In addition to physical and occupational therapy, many cerebral palsied children will need help in learning to speak properly.

Diagnostic Clinic for Rehabilitation. A. R. Shands, Jr.

J. A. M. A. **140**:937 (July 16) 1949.

With insufficient information and an inaccurate diagnosis a patient may start a program of rehabilitation totally unsuited to his handicap; hence the first major division in the organization of services for the rehabilitation of the handicapped is the diagnostic clinic. The physical qualities, mental characteristics and vocational abilities of the patient must be determined, recorded and evaluated before treatment is started. Then and then only can a rational plan leading to the restoration of this handicapped person to the best possible physical, economic and social status be formulated. The purpose of this paper is to present a few ideas on the organization and value of the diagnostic clinic for rehabilitation with several related thoughts on other problems of rehabilitation. It must be remembered that rehabilitation is an individualized process and will never lend itself to fixed and stereotyped programs. Each case represents a separate problem,

which has to be studied and judged on its own merits; hence the need for an accurate diagnosis.

In the physical medicine branch there should be a physiatrist, who is the physician trained in physical medicine, and a physical therapist, who has had special training in muscle examinations and determination of joint motion. In all of the patients with orthopedic handicaps who need rehabilitation there is some involvement of muscles and joints which must be properly examined and their functional value estimated before a sound program of rehabilitation can be decided on; hence the need for the special training of the physical therapist.

There is no doubt at present that rehabilitation is poorly understood. Few of us feel competent to practice it, and there is a vast job of education needed to bring the importance of the knowledge newly gained to the mind of the average physician. With greater experience, there will come a time when all physicians will feel a degree of confidence in what can be done for their patients with good rehabilitation and will not consider themselves educated until they know the technics and are masters of the practice of this "third phase of medicine."

Some Problems of Rehabilitation Following Injuries to the Foot and Ankle. Charles V. Hatchette.

South. M. J. 42:604 (July) 1949.

After complete healing of fractures and soft tissue damage has occurred, but continued swelling with stiffness of the ankle joint persists, active and passive exercises aid in recovery of function. Inclined boards prove very satisfactory for rehabilitation of ankle motion and patients should be advised frequently of the importance of this exercise. By this method, ligaments are strengthened, muscular action is revived, and fibrotic joints are broken up. This is by far the most satisfactory method of rehabilitation and should be practiced more frequently than is usually done. A competent nurse or physical therapist may instruct these patients. Industry probably would find the establishment of rehabilitation centers advantageous, not only because of earlier return to work, but also because of considerable savings in compensation payments and medical fees. Whirlpool baths, the use of massage, and other physical methods of rehabilitation are used advantageously in fracture centers, where frequent injuries justify large scale therapeutics. In the so-called after-treatment of fractures to the foot and ankle, it is Clay Ray Murray's belief that it is not the role of physical therapy to rehabilitate the patient. It should be used only to make it easier for the patient to rehabilitate himself.

Management of Cerebral Palsy. Frederic B. House.

J. Michigan M. Soc. 48:843 (July) 1949.

The problem of managing cerebral palsy is one of the most interesting phases of physical medicine. It is also an important aspect of the work in physical medicine. In the spastic child, treatment is directed toward individual muscles. If the muscle is spastic and shortened, it must be stretched, and this is accomplished by slow stretching, not rapid enough to elicit the stretch reflex. A trained physical therapist may find light percussion over the muscle may help in relaxing the spasm and facilitating stretching. The weak muscle must be treated with resistive exercises and massage in order to increase its tone and strength. Because of the spastic's inherent loss of many of the instinctive movement patterns that normal people are born with, exercise of the parts as a whole may be important in establishing basic action patterns. These exercises at the same time loosen stiff joints and stretch shortened muscles. Much of the problem of actual treatment has been placed on the shoulders of the physical therapist, the good results were chiefly due to her technic, aided by detailed prescription based on accurate diagnosis.

F. C. C. Rules and Regulations on Diathermy and Television Prevents Chaos in Radio Communications. Howard A. Carter.

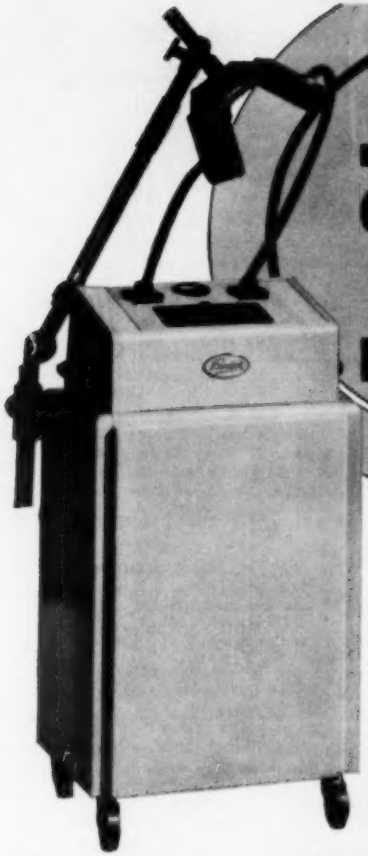
Mod. Hosp. 73:64 (Aug.) 1949.

The Federal Communications Commission has announced rules and regulations regarding the manufacture and use of diathermy equipment. These rules and regulations indicate that there are generally two methods of operating diathermy equipment in compliance with the rules for equipment manufactured after July 1, 1947. The first method is to operate within assigned frequency bands using equipment that is either "type-approved" or certified by a competent engineer in accordance with the applicable sections of the rules. The second method is to operate on any frequency provided the equipment is in a shielded room with a filtered power supply and all radiation on any frequency is limited to 15 microvolts per meter at a distance of 1,000 feet or more from the diathermy equipment. Operation in this manner also requires certification by a competent engineer. Some discussion has been raised as to the relative merits of the health of the nation and the protection of the public by the police. While a physician may be treating a disease, the police might be hampered in protecting the property of the public by interference caused by a diathermy apparatus. Fortunately, problems of this nature, if indeed they exist, can now be overcome by compliance with the regulations of the Federal Communications Commission.

Extradural Hematoma in Infancy and Childhood. Franc D. Ingraham; James B. Campbell, and Jonathan Cohen.

J. A. M. A. 140:1010 (July 23) 1949.

Extradural hematoma proved by operation occurred twenty times in a series of a little over 1,000 pediatric patients treated for head injury. The differential diagnosis is discussed. The signs manifested by the patients in the series are listed and considered in regard to the mechanics of the skull. The indications for trephination are given. This is the only certain method of diagnosis and of adequate treatment. The operative procedure is outlined. There were 2 deaths in a series of 20 infants and children.



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		Completion MFSS	12[13]	June	10	None	Certificate
Permanente School of Physical Therapy, Oakland, Calif.	O. L. Huddleston, M.D. Miss Dorothy Hoag	a-b-d	12 mos.	——	7	$200	Certificate
Cleveland Clinic Hospital, Cleveland, Ohio	Shelby G. Gamble, M.D. Miss Anna Wetterhuus	a-b-d	12 mos.	July	12	$200	Diploma

** Courses are so arranged that any of the entrance requirements will qualify students for training. a — Graduation from accredited school of nursing; b — Graduation from accredited school of physical education; c — Two years of college with science courses; d — Three years of college with science courses; e — Four years of college with science courses. H.S. — High school graduation. h — Baccalaureate degree with major in physical education or the biological sciences.

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1. Male students are admitted.
2. R.N. plus one year college.
3. Nonresidents charged additional fee.
13. 12 months includes training at the Medical Field Service School and Fitzsimons or Walter Reed General Hospitals.
14. Students may transfer into the degree course at the Freshman, Sophomore, Junior or Senior Level. All are held responsible for requirements as listed in curriculum outline. This refers to professional as well as nonprofessional courses.

APPROVED SCHOOLS FOR OCCUPATIONAL THERAPY TECHNICIANS *

Council on Medical Education and Hospitals of the American Medical Association

NOTE: The duration of the course is expressed in academic years.

Name and Location of School	College Affiliation	Duration of Course	Classes Start	Entrance Requirements	Tuition Per Year	Certificate, Diploma	Graduates in 1947
University of Southern California, 923½ 35th Place, Los Angeles	University of Southern California	2 yrs.	FebSept	Degree	$420	Certificate	22
		5 yrs.	FebSept	High sch.	$450	Cert.&B.S.	
Mills College, Oakland, Calif.	Mills College	3 yrs.	FebSept	Degree	$200	Certificate	—
					$550		
San Jose State College, San Jose, Calif.	San Jose State College	1½ yrs.	Varies	Degree	$ 21	Certificate	10
		3¼ yrs.	Varies	High sch.	$ 21	Degree	
University of Illinois College of Medicine, 1853 W. Polk St., Chicago	University of Illinois	5 yrs.	Feb	High sch.	$152	B.S.	14
University of Iowa, Iowa City, Iowa	State University of Iowa, College of Medicine	5 yrs.	.....	High sch.	$ 85	Cert.&Deg	
University of Kansas, Lawrence	University of Kansas	2 yrs.	FebSept	Degree	$131	Certificate	10
		4 yrs.	FebSept	High sch.	$131	B.S.	
Boston School of Occupational Therapy, 7 Harcourt St., Boston	Tufts College	2 yrs.	Sept	Degree	$500	Diploma	13
		5 yrs.	Sept	High sch.	$450	B.S.	
Wayne University, 4841 Cass, Detroit, Mich.	Wayne University, College of Med., Coll. of Liberal Arts, Coll. of Education	5 yrs.	.....	High sch.	.....	.....	
Kalamazoo School of Occupational Therapy, Western Michigan College of Education, Kalamazoo	Western Michigan College of Education	1½ yrs.	FebSept	Degree	$127	Diploma	20
		4 yrs.	FebSept	1 yr. coll.	$127	Degree	
Michigan State Normal College, Ypsilanti	University of Michigan	5 yrs.	Varies	High sch.	$118	Cert.&Deg.	8
University of Minnesota, Church Street, Minneapolis	University of Minnesota	4 yrs.	.....	High sch.	$360	B.S.	
College of St. Catherine, St. Paul, Minn.	The College of St. Catherine	3½ yrs.	Varies	1 yr. coll.	$210	Degree	4
Washington University School of Medicine, St. Louis	Washington University	3 yrs.	Sept	2 yrs. coll.	$400	Degree	10
University of New Hampshire, Durham	Univ. of New Hampshire	5 yrs.	Sept	High sch.	$160	Cert.&Deg.	6
Columbia University College of Physicians and Surgeons, 630 W. 168th St., New York City	Columbia University	1½ yrs.	Sept	Degree	$450	Certificate	28
		2½ yrs.	Sept	2 yrs. coll.	$450	Degree	
New York University School of Education, 100 Washington Sq. E., New York City	New York University	4½ yrs.	FebSept	High sch.	$500	Cert.&Deg.	20
Ohio State University, Columbus	Ohio State University	3 yrs.	Quarterly	High sch.	$105	Degree	21
Philadelphia School of Occupational Therapy, 419 S. 19th St., Philadelphia	University of Pennsylvania	1½ yrs.	Sept	Degree	$500	Diploma	35
		3 yrs.	Sept	1 yr. coll.	$500	Diploma	
		.....	.....	High sch.	$600	.....	
Texas State College for Women, Denton, Tex.	Texas State College for Women	5 yrs.	FebSept	High sch.	$150	Degree	13
Richmond Professional Institute, 901 W. Franklin St., Richmond, Va.	Medical College of Virginia	1½ yrs.	Sept	Degree	$200	Certificate	20
		3 yrs.	Sept	1 yr. coll.	$200	Certificate	
College of Puget Sound, Tacoma, Wash.	College of Puget Sound	3 yrs.	FebSept	Degree	$350	Certificate	
		5 yrs.	FebSept	High sch.	$300	Cert.&Deg.	
University of Wisconsin, Madison	University of Wisconsin	4 yrs.	FebSept	High sch.	$320	Cert.&Deg.	8
Milwaukee-Downer College, Dept. of Occupational Therapy, 2512 E. Hartford, Milwaukee	Milwaukee-Downer College	2½ yrs.	Sept	1 yr. coll.	$300	Diploma	22
		4 yrs.	Sept	High sch.	$300	Dipl.&Deg.	
Mount Mary College, 2900 Menomonee River Dr., Milwaukee		Varies	Sept	Degree	$335	Certificate	15
University of Toronto, Dept. of University Extension, Toronto, Ont., Canada	University of Toronto	5 yrs.	Sept	High sch.	$260	B.S.Deg.	
		3 yrs.	Sept	1 yr. coll.	$222	Diploma	110
Colorado Agricultural and Mechanical College, Fort Collins, Colorado		5 yrs.	Sept	High sch.	.....	B.S.	

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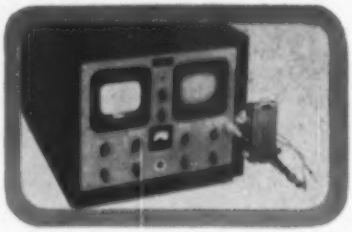

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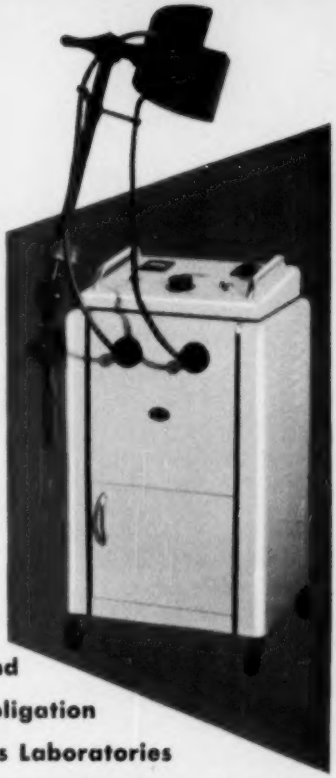

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